

Contract No.: EP-W-09-002
WA #: 060-RICO-02MV

Region 2 RAC2 Remedial Action Contract

Final Quality Assurance Project Plan

Pierson's Creek Site
Remedial Investigation/Feasibility
Study
Newark, New Jersey

February 14, 2018

**CDM
Smith**

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This QAPP is prepared in accordance with the UFP-QAPP manual (EPA 2005) and updated worksheets (2012) and is compliant with EPA's QAPP requirements document EPA QA/R-5 (EPA 2001). The project will be implemented in accordance with the quality procedures in CDM Smith's Quality Management Plan Manual (January 2018).

All worksheets are included herein.

References

CDM Smith. 2018a. Negotiated Work Plan, Volume II. Pierson's Creek Site, Remedial Investigation/Feasibility Study Oversight, Newark, New Jersey. August 3.

CDM Smith. 2018b. Quality Management Plan, Revision 3, January 29.

CDM Smith. 2017a. Revised Technical Memorandum – Summary of Existing Information and Data Gap Evaluation, Pierson's Creek Site, Newark, New Jersey, February 10.

CDM Smith. 2017b. Draft Work Plan, Volume I. Pierson's Creek Site, Remedial Investigation/Feasibility Study Oversight, Newark, New Jersey. January 26.

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Acronyms

ABS	absolute difference
amsl	above mean sea level
ANSETS	Analytical Services Tracking System
ASC	analytical services coordinator
ASQ	American Society for Quality
ATV	all-terrain vehicle
BAL	Brooks Applied Laboratories
bgs	below ground surface
CCV	continuing calibration verification
CDM Smith	CDM Federal Programs Corporation
CHMM	Certified Hazardous Materials Manager
CLP	Contract Laboratory Program
COC	chain-of-custody
CRQL	contract required quantitation limit
CSM	conceptual site model
CSP	Certified Safety Professional
CVOC	chlorinated volatile organic compound
DESA	Division of Environmental Science and Assessment
DMC	deuterated monitoring compound
DO	dissolved oxygen
DOC	dissolved organic carbon
DQA	data quality assessment
DQI	data quality indicator
DQO	data quality objective
DV	data validation
ECD	electron capture detector
EDD	electronic data deliverable
EPA	United States Environmental Protection Agency
EQulS	Environmental Quality Information Systems
ESAT	Environmental Services Assistance Team
FASTAC	Field and Analytical Services Teaming Advisory Committee
FCN	field change notification
FID	flame ionization detector
FS	feasibility study
FTL	field team leader
GC/MS	gas chromatograph/mass spectroscopy
gpm	gallons per minute
GPS	global positioning system
HCl	hydrochloric acid
HDPE	high density polyethylene
HHRA	human health risk assessment
HSA	hollow-stem auger
ICP	inductively coupled plasma
ICP-AES	inductively coupled plasma atomic emission spectroscopy
ICP-MS	inductively coupled plasma mass spectrophotometer
ICV	initial calibration verification
ID	identification
IDW	investigation derived waste

Acronyms

L	liter
LCS	laboratory control sample
MDL	method detection limit
mg/kg	milligram per kilogram
mL	milliliter
MRL	method reporting limit
MSA	master services agreement
MS/ MSD	matrix spike/matrix spike duplicate
MVA	mercury vapor analyzer
N/A	not applicable
NAPL	non-aqueous phase liquid
NELAP	National Environmental Laboratory Accreditation Program
NJDEP	New Jersey Department of Environmental Protection
NPL	National Priorities List
NTU	nephelometric turbidity units
OSR	off-site disposal rule
OU	operable unit
oz.	ounce
%R	percent recovery
PAH	polyaromatic hydrocarbons
PAL	project action limit
PCB	polychlorinated biphenyl
P.E.	Professional Engineer
P.G.	Professional Geologist
PID	photoionization detector
PM	program manager
POC	particulate organic carbon
PPE	personal protective equipment
PQLG	project quantitation limit goal
PQO	project quality objective
PTFE	polytetrafluoroethylene
PVC	polyvinyl chloride
QA	quality assurance
QAM	quality assurance manager
QAS	quality assurance specialist
QAPP	quality assurance project plan
QC	quality control
QCS	quality control sample
QL	quantitation limit
QP	quality procedures
RAC	remedial action contract
RAS	routine analytical service
RCRA	Resource Conservation and Recovery Act
RF	response factor
RI/FS	remedial investigation/feasibility study
RITM	Remedial Investigation task manager
ROV	remotely operated vehicles
RPD	relative percent difference
RPM	remedial project manager
RRF	relative response factor

Acronyms

RSCC	Regional Sample Control Center
RSD	relative standard deviation
SDG	sample delivery group
Site	Pierson's Creek Superfund Site
SLERA	screening level ecological risk assessment
SM	site manager
SOP	standard operating procedure
SOW	Statement of Work
SHSO	site health and safety officer
SPLP	synthetic precipitation leaching procedure
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TBD	to be determined
TCL	target compound list
TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TIC	tentatively identified compound
TOC	total organic carbon
TSS	total suspended solids
UFP	Uniform Federal Policy
µg	microgram
µg/kg	microgram per kilogram
µg/L	microgram per liter
UDF	United States Freightways Corporation
VOC	volatile organic compound
WA	work assignment
WS	worksheet

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1.0 Introduction

CDM Federal Programs Corporation (CDM Smith) received Work Assignment (WA) 060-RICO-02MV under the Remedial Action Contract (RAC) 2, United States Environmental Protection Agency (EPA) Region 2, to conduct the Remedial Investigation (RI)/Feasibility Study (FS) of the Pierson's Creek Superfund Site ("the Site") located in Newark, New Jersey. The Site consists of the Troy Chemical Corporation (Troy Chemical) property and Pierson's Creek, an approximately 1.5-mile man made ditch, in Newark, New Jersey.

This quality assurance project plan (QAPP) addresses the field and analytical activities that will be performed as part of the RI/FS. Activities include sampling and analysis of sediment, soil, surface water, groundwater, and air to characterize and delineate contamination throughout Pierson's Creek.

This QAPP has been prepared in accordance with the Uniform Federal Policy (UFP)-QAPP manual (EPA 2005) and optimized worksheets (EPA 2012) and is compliant with EPA's QAPP requirements document EPA QA/R-5 (EPA 2001). This QAPP is the governing document for execution of the RI field investigation.

1.1 Site Description and Background

The Pierson's Creek Site is defined by the Troy Chemical property and Pierson's Creek, an approximately 1.5-mile man made ditch located in Newark, New Jersey (Figure 1). The Site has been separated into two operable units (OUs); OU2 is defined as all site features on the Troy Chemical property and OU1 encompasses the rest of the Site. This QAPP addresses RI field activities at OU1. More in depth site descriptions, history, and background are provided in a technical memorandum prepared to collect existing information about the Site prior to the RI investigation and the RI Work Plan for this work assignment (CDM Smith 2017a and CDM Smith 2017b).

Pierson's Creek runs north to south through the central portion of Troy Chemical, a chemical manufacturing facility that formerly discharged mercury bearing wastewaters to Pierson's Creek. Much of the creek has been channelized, as it has been used as an urban stormwater drainage structure for more than 100 years. The creek historically surfaced from a 36-inch stormwater culvert just to the north of Troy Chemical, and flowed in the concrete channel that bisects the Troy Chemical facility. An unnamed, intermittent drainage ditch flowed along the eastern property boundary and joined Pierson's Creek just south of the facility where the creek then extended to the Port Newark Channel of Newark Bay. Since a drainage improvement in 2007, the perennial portion of Pierson's Creek now begins just south of Troy Chemical facility. The portion of the creek on the Troy Chemical property has been blocked at both ends and has been covered as a temporary measure to limit precipitation from entering the creek.

Pierson's Creek flows through a series of open channels and culverts, in a general south-southwesterly direction for approximately 1.5 miles to the Port Newark Channel portion of Newark Bay. After passing through Troy Chemical, the creek flows south through the former Red Star property (currently occupied by Continental Hardware), the vacant former Engelhard property (currently owned by 429 Delancy Associates LLC), Conrail's Oak Island rail yard, and private parking lots built on a former landfill within the Port of Newark. The creek flows through these properties for approximately 1 mile before being routed through culverts beneath Interstate 78, Newark International Airport, and New Jersey Turnpike.

In 2012, EPA conducted an investigation of Pierson's Creek which confirmed the observed release of mercury to the creek sediments. Mercury, a number of other metals, and polychlorinated biphenyls (PCBs) were detected in sediment samples collected throughout the accessible portions of the creek. As a result of

this investigation, EPA placed the Pierson's Creek site on the National Priorities List (NPL) in September of 2014.

1.2 Purpose of the QAPP

The primary objective of the RI is to determine the nature and extent of contamination in sediment, soil, surface water, and groundwater and to collect sufficient data to complete risk assessments and an FS for the Site. This QAPP serves to detail activities and procedures required to collect data for the RI. This QAPP provides information and procedures to collect field samples for the following field activities:

- Groundwater studies (includes an existing monitoring well assessment, groundwater/surface water interaction studies, synoptic water level measurements, and monitoring well installations)
- Sediment sampling program
- Soil sampling program
- Surface water sampling program
- Groundwater sampling program
- Air sampling

The following UFP-QAPP worksheets provide details on the organization, data quality objectives (DQOs), sampling and analytical procedures, quality assurance (QA)/quality control (QC) requirements, project tasks, rationale for the work, and assessments and reporting protocols. Sample collection procedures are included in Worksheet #17 and in Appendix A. Field forms to be used for the collection of field data are provided in Appendix B. Sample types and analyses are described in Worksheets 17 and 18. Sample analyses will proceed via the EPA Region 2 Field and Analytical Services Teaming Advisory Committee (FASTAC) process using Division of Environmental Science and Assessment (DESA), EPA Contract Laboratory Program (CLP), and subcontracted laboratories.


QAPP Worksheets #1 and #2: Title and Approval Page
(UFP-QAPP Manual Section 2.1)
(EPA 2106-G-05 Section 2.2.1)

Contract: RAC 2, EPA Region 2 EP-W-09-002

Work Assignment Number/Operable Unit: 060-RICO-02MV

Document Control No.: 3323-060-03778

CDM Smith Site Manager (SM):
Edward Leonard

Signature 

CDM Smith QA Manager (QAM):
Jo Nell Mullins

Signature 

EPA Remedial Project Manager (RPM):
Pamela Tames

Signature _____

RAC 2 Region 2 Deputy Program Manager (DPM):
Brendan C. MacDonald, P.E., BCEE, LEED® AP

Signature 

EPA Quality Assurance Officer:
Phil Cocuzza

Signature _____

State Regulatory Agency /Stakeholders (name/title/signature/date) (as applicable):
New Jersey Department of Environmental Protection (NJDEP)

Dates and Titles of Plan and Reports Written for Previous Site Work, if Applicable:
Historical documents summarized in Revised Technical Memorandum – Summary of Existing Information and Data Gap Evaluation, Pierson's Creek Site, Newark, New Jersey, February 10, 2017.

Required QAPP elements and required information that are not applicable to the project, and an explanation for their exclusions:
All worksheets included.

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QAPP CROSSWALK

Identifying Information

Optimized UFP-QAPP Worksheets		2106-G-05 QAPP Guidance Section	
1 & 2	Title and Approval Page	2.2.1	Title, Version, and Approval/Sign-Off
3 & 5	Project Organization and QAPP Distribution	2.2.3	Distribution List
		2.2.4	Project Organization and Schedule
4, 7 & 8	Personnel Qualifications and Sign-off Sheet	2.2.1	Title, Version, and Approval/Sign-Off
		2.2.7	Special Training Requirements and Certification
6	Communication Pathways	2.2.4	Project Organization and Schedule
9	Project Planning Session Summary	2.2.5	Project Background, Overview, and Intended Use of Data
10	Conceptual Site Model	2.2.5	Project Background, Overview, and Intended Use of Data
11	Project/Data Quality Objectives	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
12	Measurement Performance Criteria	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
13	Secondary Data Uses and Limitations	Chapter 3	QAPP ELEMENTS FOR EVALUATING EXISTING DATA
14 & 16	Project Tasks & Schedule	2.2.4	Project Organization and Schedule
15	Project Action Limits and Laboratory-Specific Detection / Quantitation Limits	2.2.6	Data/Project Quality Objectives and Measurement Performance Criteria
17	Sampling Design and Rationale	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
18	Sampling Locations and Methods	2.3.1	Sample Collection Procedure, Experimental Design, and Sampling Tasks
		2.3.2	Sampling Procedures and Requirements
19 & 30	Sample Containers, Preservation, and Hold Times	2.3.2	Sampling Procedures and Requirements
20	Field QC	2.3.5	Quality Control Requirements
21	Field SOPs	2.3.2	Sampling Procedures and Requirements
22	Field Equipment Calibration, Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
23	Analytical SOPs	2.3.4	Analytical Methods Requirements and Task Description
24	Analytical Instrument Calibration	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables

QAPP CROSSWALK

Identifying Information

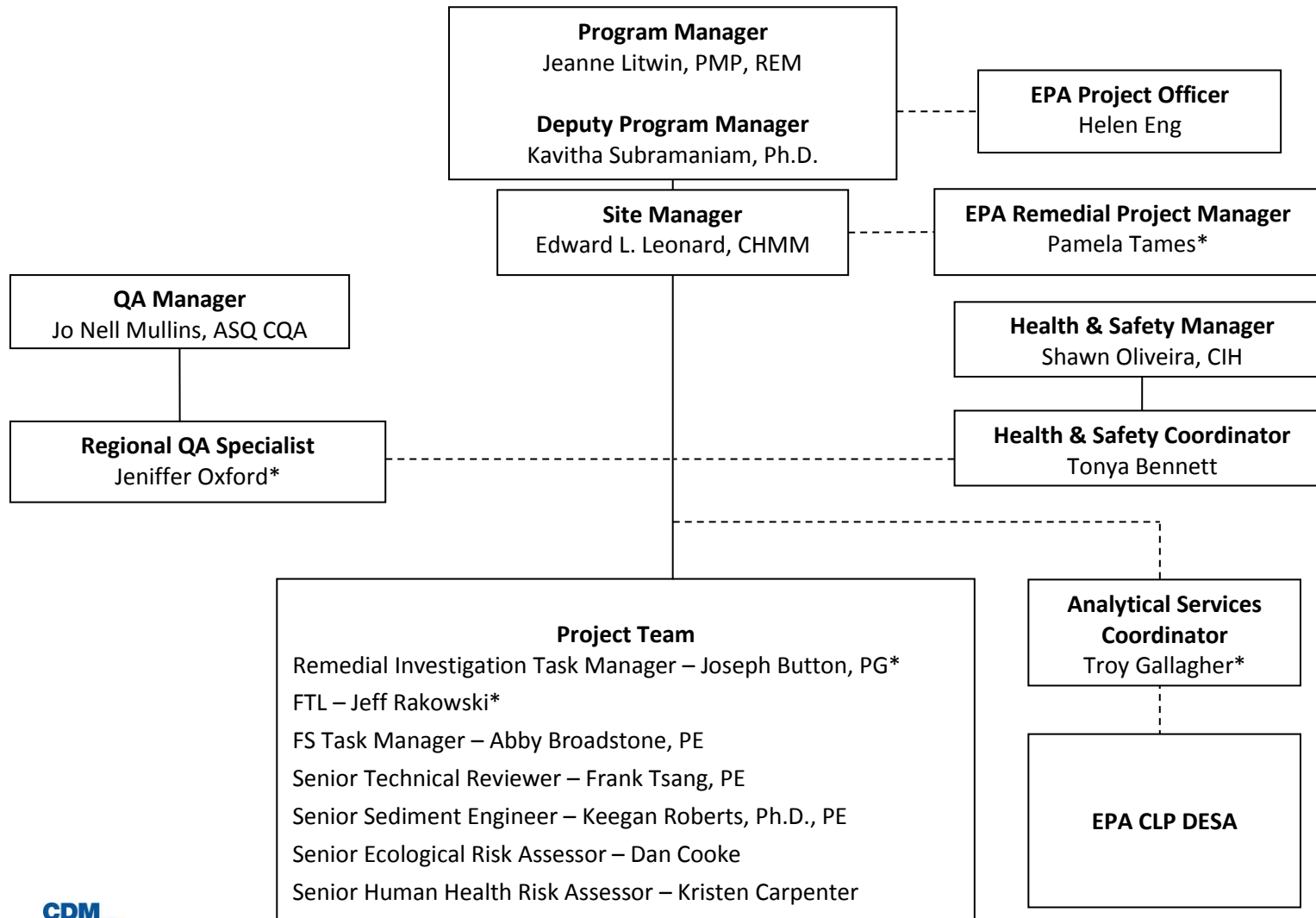
Optimized UFP-QAPP Worksheets		2106-G-05 QAPP Guidance Section	
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection	2.3.6	Instrument/Equipment Testing, Calibration and Maintenance Requirements, Supplies and Consumables
26 & 27	Sample Handling, Custody, and Disposal	2.3.3	Sample Handling, Custody Procedures, and Documentation
28	Analytical Quality Control and Corrective Action	2.3.5	Quality Control Requirements
29	Project Documents and Records	2.2.8	Documentation and Records Requirements
31, 32 & 33	Assessments and Corrective Action	2.4	Assessments and Data Review
		2.5.5	Reports to Management
34	Data Verification and Validation Inputs	2.5.1	Data Verification and Validation Targets and Methods
35	Data Verification Procedures	2.5.1	Data Verification and Validation Targets and Methods
36	Data Validation Procedures	2.5.1	Data Verification and Validation Targets and Methods
37	Data Usability Assessment	2.5.2	Quantitative and Qualitative Evaluations of Usability
		2.5.3	Potential Limitations on Data Interpretation
		2.5.4	Reconciliation with Project Requirements

QAPP Worksheet #3 and #5: Project Organization and QAPP Distribution
(UFP-QAPP Manual Section 2.3 and 2.4)
(EPA 2106-G-05 Section 2.2.3 and 2.2.4)

*QAPP recipient

Lines of authority —————

Lines of Communication - - - - -



**QAPP Worksheet #4, 7, and 8: Personnel Qualifications and Sign-off Sheet
(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)
(EPA 2106-G-05 Section 2.2.1 and 2.2.7)**

ORGANIZATION: CDM Smith

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date
Edward Leonard	Site Manager (SM) – Oversees project and responds to EPA RPM. Manages subcontractors. Responsible for implementing and maintaining QA program. Determines the need for any corrective action.	B.S., Biology; M.S., Environmental Science; 30 years of experience	Certified Hazardous Materials Manager (CHMM)	
Joe Button	RI Task Manager (RITM) – Oversees RI tasks. Provides guidance on implementation of the field investigation and preparation of RI report.	B.A., Geology; 16 years of experience	Professional Geologist (P.G.)	
Abby Broadstone	Feasibility Study Task Manager (FSTM) – Oversees FS tasks. Provides guidance on direction of the FS and preparation of the FS report.	B.S. Biological Engineering; M.S. Agricultural Engineering; 12 years of experience	Professional Engineer (P.E.)	
Jeff Rakowski	Field Team Leader (FTL) – Responsible for coordination and execution of all field activities outlined in the QAPP.	B.A., Geography; 13 years of experience	Certified Safety Professional (CSP)	
Frank Tsang, P.E.	Senior Technical Reviewer 1 (STR 1) – Provides a technical review of RI/FS documents.	B.S. & M.S., Chemical Engineering; 35 years of experience	P.E.	
Keegan Roberts, Ph.D., P.E.	Senior Sediment Engineer – Provides guidance on RI/FS documents.	B.S., Civil Engineering; M.S., Civil Engineering; PhD, Civil Engineering	P.E.	

QAPP Worksheet #4, 7, and 8: Personnel Qualifications and Sign-off Sheet
(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)
(EPA 2106-G-05 Section 2.2.1 and 2.2.7)

Name	Project Title/Role	Education /Experience	Specialized Training/Certifications ¹	Signature/Date ²
Dan Cooke	Senior Ecological Risk Assessor (SERA) – Oversees the completion of the Ecological Risk Assessment	B.S. Marine Biology; M.S. Biology; 29 years of experience		
Kristen Carpenter	Senior Human Health Risk Assessor (SHHRA) – Oversees the completion of the Human Health Risk Assessment (HHRA)	B.S. Biology; M.S. Environmental Health and Management; over 20 years of experience		
John Dougherty, P.G.	Project Hydrogeologist (HDRO) – Provides a technical review of geologic data	B.S. Geosciences; 35 years of experience	P.G.	
Troy Gallagher	Analytical Services Coordinator (ASC) – Coordinates with EPA Regional Sample Control Center (RSCC), DESA laboratory, and subcontract laboratories, reviews trip reports	B.S., Environmental Science B.S., Engineering Technologies 15 years of experience		
Jo Nell Mullins	Quality Assurance Manager (QAM) – Develops and implements CDM Smith's QA program and oversees assessment of implementation of quality requirements for all projects	M.S., Environmental Health B.S., Biology/Chemistry 15 years of experience	American Society for Quality (ASQ) Certified Quality Auditor; ISO 14001 Lead Auditor Certified; Nuclear Quality Assurance-1 Lead Auditor Certified	
Jeniffer Oxford	QA Specialist (QAS) – Oversees adherence to QA requirements	B.S., Natural Sciences; 28 years of experience		
Christine Julias	Database Manager (DM) – Oversees data management and troubleshoots any issues, performs data manager review prior to data release, ensures final electronic data deliverable (EDD) is prepared for client submittal	B.S., Chemical Engineering; M.B.A., Marketing Management; 15 years of experience		
Tonya Bennett	Data Coordinator (DC) – Facilitates data management planning, receives data and EDDs, maintains project tracking sheet, ensures all data are received	B.S. Geology; M.S. Environmental Technology; 14 years of experience		

QAPP Worksheet #4, 7, and 8: Personnel Qualifications and Sign-off Sheet
(UFP-QAPP Manual Sections 2.3.2 – 2.3.4)
(EPA 2106-G-05 Section 2.2.1 and 2.2.7)

ORGANIZATION: EPA³

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date²
Pamela Tames	RPM			

ORGANIZATION: Laboratories

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications	Signature/Date²
EPA CLP Laboratory (to be determined [TBD])	QA Officer	TBD (Experience vetted by accreditation body)	National Environmental Laboratory Accreditation Program (NELAP)/CLP	
DESA – Sumy Cherukara	QA Officer	TBD (Experience vetted by accreditation body)	NELAP/Trained in EPA and standard analytical methods	
Subcontract Laboratories	QA Officer	TBD (Experience vetted by accreditation body)	Laboratory in-house and external training – vetted by NELAP	

Notes:

1. CPR/First Aid- Red Cross or CINTAS – periodically as required (1-3 years).
2. Signatures indicate personnel have read and agree to implement this QAPP as written.
3. EPA Headquarters staff reviews and maintains the résumés of education and experience for key laboratory staff. This information is not available for the QAPP.
4. Subcontract laboratories have not yet been procured. Once the subcontract laboratories are procured this information will be provided to EPA.

QAPP Worksheet #6: Communication Pathways
(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)

Communication Driver	Organization	Name	Contact Information	Procedure (Timing, Pathways, Documentation, etc.)
Regulatory agency interface	CDM Smith SM	Edward Leonard	732-590-4695	The CDM Smith SM will send all information about the project to the EPA RPM. Field changes will be discussed with the EPA RPM prior to implementation.
Manage field tasks	CDM Smith RITM	Joe Button	212-377-4389	Act as liaison to SM concerning investigation activities. Daily communication with project team and SM. Communicate implementation issues to FTL.
QAPP changes: prior to fieldwork, in the field, and during project execution	CDM Smith RITM	Joe Button	212-377-4389	FTL will notify RITM immediately and promptly complete a Field Change Notification (FCN) form and/or corrected worksheets. Send FCN forms to QAS. RITM to notify SM and ASC of delays or changes to field work. Prepare QAPP Addendums or revisions in consultation with the client.
	CDM Smith FTL	Jeff Rakowski	732-590-4665	
	CDM Smith SM	Edward Leonard	732-590-4695	Notify EPA RPM and ASC of delays or changes to field work. Prepare QAPP addendums or revisions in consultation with the client.
Field corrective actions	CDM Smith FTL	Jeff Rakowski	732-590-4665	CDM Smith FTL will oversee implementation of corrective action and notify SM by email. CDM Smith SM will complete the corrective action report form.
	CDM Smith FTL	Jeff Rakowski	732-590-4665	Complete daily report or summary and submit to CDM Smith SM and RITM. CDM Smith SM will forward to EPA RPM upon request.
Booking analytical services	CDM Smith FTL	Jeff Rakowski	732-590-4665	Submit request to ASC before the timeframe below.
	CDM Smith ASC	Troy Gallagher	732-590-4706	Coordinate DESA and CLP analytical services through RSCC 3 weeks prior to sampling. Six (6) weeks advance submittal required for modified analysis and special requests.
Facilitate database setup and data management planning	CDM Smith FTL	Jeff Rakowski	732-590-4665	Provide sample identification (ID), locations, and analyses prior to sample collection to CDM Smith ASC and DC. Provide DC and DM with sample and analytical reporting groups, screening criteria and types of report tables required for project.
Facilitate data management	CDM Smith RITM	Joe Button	212-377-4389	Transmit completed sample tracking information and field EDD to data manager by the completion of each sampling case.
	CDM Smith DC	Tonya Bennett	212-377-4532	

QAPP Worksheet #6: Communication Pathways
(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)

Communication Driver	Organization	Name	Contact Information	Procedure (Timing, Pathways, Documentation, etc.)
Incomplete EDDs or other EDD issues	CDM Smith DM	Christine Julias	732-590-4610	Personnel identifying the issue (validator, DC, ASC) will notify DM who will request resubmittal of corrected EDD by email.
Data verification issues, e.g., incomplete records	CDM Smith DM	Christine Julias	732-590-4610	DC will send an email to the DM when an issue is found. DC or DM will address questions or any discrepancies.
Field corrective action	CDM Smith QAS, RITM, FTL	Jeniffer Oxford Joe Button Jeff Rakowski	212-377-4536 212-377-4389 732-590-4665	SM, RITM, and FTL will identify corrective actions. Corrective actions may also be identified by the field team. FTL initiates corrective action on identified field issues immediately or within QAM recommended timeframe.
Procurement of subcontract analytical services	CDM Smith FTL/ASC	Jeff Rakowski Troy Gallagher	732-590-4665 732-590-4706	FTL will prepare laboratory request; ASC will review and send email to RSCC. The project chemist will prepare an analytical statement of work (SOW) for the subcontract laboratories and submit for review. FTL, or ASC will initiate a kick-off call with subcontract laboratory (ies) and email agenda.
Analytical services support	CDM Smith ASC	Troy Gallagher	732-590-4706	Act as liaison with RSCC for CLP laboratories, with Ness Tirol for DESA, and with subcontract laboratory (ies). Coordinate data validation for data sent to the subcontract laboratories.
Laboratory quality control (QC) variances and analytical corrective actions	DESA or subcontract laboratory manager or QC Officer, or RSCC	TBD	TBD	Communicate with CDM Smith ASC, QAS, or designee. Provide oversight and direction on technical issues as needed.
Notification of analytical issues sample receipt variances	CDM Smith ASC	Troy Gallagher	732-590-4706	Notify FTL of any sample collection/shipment issues. Respond to RSCC, DESA or subcontract laboratories to initiate corrective action. Elevate to RITM or SM as needed.
Reporting of issues relating to analytical data quality (including ability to meet reporting limits and usability of data)	CDM Smith ASC	Troy Gallagher	732-590-4706	Communicate to CDM Smith SM and project team as appropriate.
	CDM Smith Data Validator	Cherie Zakowski	720-264-1109	Communicate to CDM Smith SM as appropriate. Document results and data impacts in the Data Validation Report.

**QAPP Worksheet #6: Communication Pathways
(UFP-QAPP Manual Section 2.4.2)
(EPA 2106-G-05 Section 2.2.4)**

Communication Driver	Organization	Name	Contact Information	Procedure (Timing, Pathways, Documentation, etc.)
Release of analytical data	CDM Smith DM	Christine Julias	732-590-4610	Assign and oversees review of database after receipt of all data. Signs release of hold point release form to facilitate use of data for reporting purposes.
Site health and safety issues	CDM Smith Site Health and Safety Officer (SHSO)	Jeff Rakowski	732-590-4665	Make decisions regarding health and safety issues and upgrading personal protective equipment (PPE). Communicate to CDM Smith SM and Health and Safety Manager, as appropriate.

QAPP Worksheet #9: Project Planning Session Summary
(UFP-QAPP Manual Section 2.5.1)
(EPA 2106-G-05 Section 2.2.5)

Projected Date(s) of Sampling: Not discussed			Site Name: Pierson's Creek Site OU1	
CDM Smith Site Manager: Edward Leonard			Site Location: Newark, NJ	
Date of Session: June 15, 2016				
Scoping Session Purpose: Project Scoping Meeting Summary				
Name	Affiliation	Phone #	E-mail Address	Project Role
Michael Clemetson	EPA	(732) 321-6712	clemetson.michael@epa.gov	EPA Ecological Risk Assessor
Nick Mazziotta	EPA	(212) 637-3920	mazziotta.nicholas@epa.gov	EPA Risk Assessor
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Comments/Decisions:

CDM Smith discussed the preliminary conceptual site model (CSM) as presented in the Technical Memorandum submitted to EPA. CDM Smith and EPA discussed the scope of the RI/FS. EPA clarified that the RI/FS does not include the Troy Chemical property, as the remediation on the property will be handled by the PRP, Troy Chemical. The scope of the RI/FS for OU1 includes Pierson's Creek and the drainage ditches and point sources that discharge to Pierson's Creek, adjacent soil sources that could enter the creek by overland flow, and contaminated groundwater that discharges to the creek. The length of Pierson's Creek included in the OU1 investigation was defined as the portion immediately south of Troy Chemical extending to and including the Port Newark Channel of Newark Bay. However, in later scoping calls and correspondence, the scope was revised as the length of Pierson's Creek immediately south of Troy Chemical extending to, but not including the Port Newark Channel of Newark Bay. In addition, during the scoping meeting, EPA indicated that discharge of contaminated groundwater into the Creek and storm sewers that contribute contaminants to the creek should be investigated during the RI. In addition, EPA asked NJDEP to provide the groundwater remedy for the former Albert Steel Drum property (currently occupied by FedEx).

An additional meeting was held on April 24, 2017 which included personnel from Troy Chemical. This meeting mainly focused on the path forward for OU2 and did not include information relevant to the RI field investigation for OU1.

QAPP Worksheet #10: Conceptual Site Model
(UFP-QAPP Manual Section 2.5.2)
(EPA 2106-G-05 Section 2.2.5)

A preliminary CSM was developed based on the existing information summarized in the 2017 Technical Memorandum (CDM Smith). The CSM provides a framework for evaluation of the existing data and development of recommendations. The CSM will be updated and refined in the RI Report as more information becomes available through the RI field program.

Site Topography and Drainage

The topography in the area is relatively flat with surface elevations generally less than 10 feet above mean sea level (amsl) between the Troy Chemical property and Newark Bay. The area surrounding the creek was formerly part of the Newark Meadows swamplands, which was filled in the 1940s to 1950s by the City of Newark for development purposes (Matrix 2007). Historical information indicates that the industrial area around the Troy Chemical property is poorly drained and subject to periodic flooding. Surface water drainage in the area is directed towards Pierson's Creek and its associated wetlands. In addition, several industrial properties have historically discharged directly to the creek. Pierson's Creek has been channelized along much of its length by the City of Newark and includes engineered structures such as concrete-lined flumes and culverts.

Geology and Hydrology

The site is located in the New Jersey Piedmont geological province, often referred to as the Piedmont Plateau. The site is underlain by the Passaic Formation Mudstone Facies of the Brunswick Group. Overlying the bedrock are thick layers of glacial drift and till, overlain by more modern marsh peat deposits which were filled during the 20th century. Groundwater is found in both the shallow overburden and the deep bedrock aquifers. Though shallow drainage features throughout the site impact groundwater flow, in general, groundwater flows south to the southeast towards Newark Bay. In areas where the creek is unlined or lined with permeable material, it is believed that groundwater discharges to the creek. Groundwater in the shallow overburden is believed to be encountered between 2 and 6 feet below ground surface (bgs) throughout the site.

Sources and Extent of Contamination

Contaminants identified at the Site during past investigations include volatile organic compound (VOCs), chlorinated volatile organic compounds (CVOs), semivolatile organic compounds (SVOCs), polyaromatic hydrocarbons (PAHs), petroleum hydrocarbons, pesticides, polychlorinated biphenyls (PCBs), and a range of metals including arsenic, cobalt, copper, lead, mercury, and zinc. The media effected includes sediment, soil, surface water, and groundwater. Given Pierson's Creek location in a heavily industrialized area of Newark, the sources of contamination in most cases are discharges, spills, and releases from these industrial processes. Troy Chemical's historic discharges of mercury bearing wastewaters to Pierson's Creek are responsible for the widespread mercury contamination. Several underground fuel storage tanks also contributed to petroleum hydrocarbon and VOC contamination. Due to mercury's toxicity, persistence, and bioaccumulation factors, it is the primary contaminant. While high concentrations of mercury are expected, methylmercury is also anticipated to be present at the site as mercury can be transformed into methylmercury by the action of sulfate reducing bacteria.

**QAPP Worksheet #10: Conceptual Site Model
(UFP-QAPP Manual Section 2.5.2)
(EPA 2106-G-05 Section 2.2.5)**

Potential migration pathways include:

- Erosion of contaminated surface soil
- Transport of sediment, particularly during storm events
- Groundwater discharge to the creek
- Surface water and sediment contaminants deposited along and the creek banks and flood plains
- Contaminated soils from excavated creek sediment (sidecast area)

Major exposure pathways for human receptors include:

- Direct exposure to contaminated soil, sediment, and surface water
- Exposure through consumption of contaminated fish and shellfish (Newark Bay)

Major exposure pathways for ecological receptors:

- Direct exposure to contaminated water, sediment, and soil
- Ingestion of contaminated prey/plants
- Direct uptake of contaminants in soil, sediment, and water by plants

Expected Transport and Fate of Site Contaminants

It is believed that direct discharges are primarily responsible for transporting contamination from surrounding industrial properties to Pierson's Creek. However, contaminants such as mercury, PCBs, and PAHs have high partition coefficients and bind to soil and sediment particles that can be transported through erosion of surface soil or transport of sediment during storm events. Remediation activities have occurred on some of the properties, and some properties are entirely covered with concrete or asphalt limiting the transport of contaminants through these pathways. However, in some uncovered areas adjacent to the creek, runoff from the soil can flow into Pierson's Creek. Additional transport mechanisms of site contaminants include the discharge of contaminated groundwater to surface water and the frequent floods of Pierson's Creek. Historical information indicates that Pierson's Creek frequently floods, providing a potential pathway for contaminants in surface water and sediment in the creek to be deposited in floodplains and wetlands adjacent to the creek.

QAPP Worksheet #11: Project Data Quality Objectives
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

1. **State the Problem** – Historical discharges from Troy Chemical led to mercury contamination within the sediments of Pierson’s Creek. Previous site investigations have provided data that are insufficient to determine the full sitewide nature and extent of contamination and to develop a complete and accurate HHRA and ecological risk assessment. This RI will provide the necessary data to develop remedial alternatives for OU1 of the Pierson’s Creek site. Specific objectives of the investigation are provided below.

2. **Identify Study Goals** – The primary goals of the RI field program described in this QAPP are to:
 - Create a comprehensive survey that covers site topography, channel dimensions of the creek and its drainage ditches, and locations/elevations of site features including culverts, manholes, and monitoring wells
 - Identify potential cultural resources that may be impacted during a remedial action
 - Refine the CSM to address current site conditions; the updated CSM, to be presented in the RI report, will be developed from field observations and data collected during the field investigation phase
 - Evaluate the nature and extent of contamination in sediments
 - Confirm the depth of sediments throughout the creek and inside the various culverts
 - Determine if the frequent flooding of the creek is depositing contaminated sediments on the creek banks
 - Determine if contamination exists in sediments within the creek
 - Determine if and at what concentration elemental mercury trapped in sediments is volatilizing to the air
 - Evaluate the nature and extent of contamination in soil
 - Determine if frequent flooding of the creek is depositing contaminants into wetlands adjacent to Pierson’s Creek
 - Evaluate the nature and extent of contamination in surface water
 - Determine if contaminated groundwater is discharging to the creek
 - Determine if contaminants persist in the surface water
 - Evaluate the nature and extent of contamination in groundwater
 - Characterize the types and concentrations of chemical contaminants including VOCs, SVOCs, pesticides, PCBs, dioxins/furans, and inorganics (metals, cyanide, mercury, and methylmercury)
 - Characterize the predominant forms of mercury through mercury speciation
 - Determine if elemental mercury is trapped in the sediments within the creek
 - Identify areas of high mercury contamination
 - Obtain data in support of conducting:
 - A preliminary and final baseline HHRA
 - A preliminary and final screening level ecological risk assessment (SLERA)
 - An FS

QAPP Worksheet #11: Project Data Quality Objectives
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

3. Identify Information Inputs – The primary required data types will be analytical results of sediment, soil, surface water, groundwater, and air samples collected from Pierson's Creek. Sediment and soil samples will be analyzed for VOCs, SVOCs, pesticides, PCBs, metals, cyanide, mercury, methylmercury, and several geotechnical parameters. In addition, sediment samples will be analyzed for dioxins/furans, volatile mercury, mercury by sequential extraction, and waste characterization parameters. Surface water and groundwater samples will be analyzed for VOCs, SVOCs, pesticides, total and dissolved metals, mercury, and cyanide, and several water quality parameters. In addition, surface water samples will be analyzed for methylmercury. Additional data to be collected includes synoptic water levels, lithological data, and completed topographic and bathymetric surveys.

4. Define the Boundaries of the Study – The horizontal spatial boundaries of the investigation are defined by Pierson's Creek, its drainage ditches/tributaries, wetlands areas surrounding Pierson's Creek, and any point or non-point sources discharging to the creek. The portion of Pierson's Creek to be investigated is defined as the portion immediately south of Troy-Chemical extending to, but not including the Port Newark Channel of Newark Bay. Sediment samples will be taken from within Pierson's Creek, the creek banks, and the various drainage ditches/tributaries. Soil samples will be taken in wetlands areas surrounding Pierson's Creek. Surface water samples will be collected from Pierson's Creek, its drainage ditches/tributaries, and Port Newark Channel. Groundwater samples will target the shallow groundwater aquifer that interacts with the surface water in Pierson's Creek.

The temporal boundary if the field investigation is the nine months estimated to complete the field investigation. The field investigation is slated to begin in October 2018 and finish in June 2019.

5. Determine the Analytical Approach – The analytical program includes the following components:

Sediment Sampling Program:

- Fifty-one (51) sediment cores advanced within Pierson's Creek, the creek banks, and its drainage ditches/tributaries. Seven samples will be taken from each core.
- Eight grab samples will be taken from within the culverted section of Pierson's Creek.
- All samples will be analyzed for VOCs, SVOCs, pesticides, PCBs, metals, cyanide, mercury, methylmercury, and several geotechnical parameters. Two samples per core will be analyzed for volatile mercury. All sample intervals at cores in the main transects will be analyzed for dioxins/furans. Samples from the 0-0.5-foot interval at all cores will be analyzed for mercury by sequential extraction.
- Seven air samples will be collected at the main transects and analyzed for mercury vapor using sorbent tubes. The air samples are meant to determine if potential elemental mercury trapped in sediments is volatilizing to the air. Additional air samples may be taken if high concentrations of mercury vapor are identified on the mercury vapor analyzer (MVA) used to screen the sediment cores.
- Five samples will be analyzed for waste characterization characteristics.

**QAPP Worksheet #11: Project Data Quality Objectives
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)**

Soil Sampling Program:

- Twenty-two (22) borings will be advanced in wetland areas surrounding Pierson's Creek. An additional five borings in the middle creek section will be advanced by the property owner's consultant and CDM Smith will manage the data.
- Four samples will be collected from each boring.
- All samples will be analyzed for VOCs, SVOCs, pesticides, PCBs, metals, cyanide, mercury, methylmercury, and several geotechnical parameters.

Surface Water Sampling Program

- The surface water sampling program will be split into two events: one dry weather event and one wet weather event.
- Thirty-seven (37) surface water samples will be collected from Pierson's Creek and its drainage ditches/tributaries. Sample locations will include the upper, middle, and lower creek sections, as well as the culverted section, portion that discharges to Port Newark channel, and point and non-point sources.
- Samples will be analyzed for VOCs, SVOCs, pesticides, PCBs, total and dissolved metals, cyanide, and mercury, methylmercury, and several water quality parameters.

Groundwater Sampling Program

- Twenty-four (24) wells will be installed. Six transects of 4 wells each will be installed in the upper and middle creek sections. Two transects of two wells each will be installed in the lower creek section.
- All samples will be analyzed for VOCs, SVOCs, pesticides, PCBs, total and dissolved metals, mercury, and cyanide, and several water quality parameters.

6. Project Decision Conditions ("If..., then..." statements)- If the vertical and horizontal boundaries of potential contamination in sediment, soil, surface water, and groundwater can be defined by data collected during the RI field program, then no further field investigations will be conducted, and remedial alternatives will be evaluated in the FS based on these boundaries. If boundaries remain undefined, CDM Smith will prepare recommendations and confer with EPA to determine the course of action.

QAPP Worksheet #11: Project Data Quality Objectives
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

7. Select Performance and Acceptance Criteria – Definitive-level data are required for select parameters and analytes of interest to meet the project objectives. The project action limits (PALs) and quantitation limits (QLs) for each sampled media are specified on Worksheet #15.

Analytical services will be procured via the EPA Field and Analytical Services Teaming Advisory Committee (FASTAC) strategy, giving priority to DESA (tier 1), and CLP laboratories (tier 2), and regional modification or contracts (tier 3). Tier 4 subcontract laboratories will be used where analytical services or capacity are not available via the first 3 tiers.

Data must meet the data quality objectives (DQOs) specified for the parameters in this QAPP to support RI study goals decisions. Worksheets #12 and 28 show the measurement performance criteria that are needed for the data quality indicators (DQIs). Worksheet #20 specifies the QC samples that will be collected to demonstrate compliance with performance criteria and to support DQOs.

For the complex mercury analyses, CDM Smith will use the data validation procedures on worksheet (WS) #36 modified by the requirements of the method and this QAPP. Validated data will be assessed to determine data quality and usability as described in Worksheet #37. Data validation and data quality assessment will determine if collected data can be used for RI evaluation and completion of the HHRA, SLERA, and FS. In addition, evaluation of analytical results will include comparison to the selected screening criteria.

8. Detail the Plan for Obtaining Data – Sampling locations were selected based on review of previous investigations and the preliminary CSM. In addition, sampling locations were chosen to delineate contamination in Pierson's Creek, its drainage ditches/tributaries, surrounding wetlands, associated groundwater aquifers, and point/non-point sources.

See Worksheet #17 and associated standard operating procedures for detailed sampling plans for each RI activity.

Data Reporting

Samples analyzed by CLP will be validated by an EPA contractor or EPA staff. DESA QA staff will validate samples analyzed by the DESA laboratory staff. CDM Smith staff will validate complex mercury samples analyzed by the subcontract laboratory. DESA and CLP validated analytical data will be forwarded to CDM Smith for evaluation and use in the RI/FS reports. Analytical data will be uploaded to the project's Environmental Quality Information System (EQUIS) database. The database query and reporting tools will be used to create a project data management system as specified by the project team. CDM Smith will submit EDDs to EPA in the EPA Region 2 format.

QAPP Worksheet #11: Project Data Quality Objectives
(UFP-QAPP Manual Section 2.6.1)
(EPA 2106-G-05 Section 2.2.6)

Data archiving

- Validated data will be downloaded from the EPA website or emailed to CDM Smith.
- Subcontract data will be submitted to CDM Smith in electronic format consistent with CLP deliverables
- Electronic data will be input into the project's EQuIS database.
- EPA will archive CLP laboratory raw data in its document control system.
- Hard copies of analytical data received by CDM Smith will be archived in the project files for 10 years after contract expiration.

QAPP Worksheet #12a: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Target compound list (TCL) VOCs/SOM02.4
Concentration Level Trace or Low (microgram per liter [µg/L])

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Overall Precision	Field duplicates	≤40 percent relative percent difference (RPD) when VOCs in both samples ≥ 5x contract required quantitation limit (CRQL) otherwise absolute difference (ABS) ≤2x CRQL when one or both results < 5x CRQL
Overall Accuracy/Bias (contamination)	Trip blank*	No analyte > CRQL No target analyte concentrations ≥ CRQL
Precision	Matrix spike(MS)/matrix spike duplicate (MSD)**	See Worksheet #28 for compound-specific values
Accuracy	***Deuterated monitoring compounds (DMC); MS/MSD**	See Worksheet #28 for list of compound-specific values and range of acceptable percent recoveries (%Rs)
Sensitivity	Method blank	Results ≤ CRQL
Completeness	Data assessment Verification and Completeness Checks	≥90 percent valid data versus total data collected and ≥90 percent planned data versus data collected See Worksheet #34

*Reference EPA Region 2 Standard Operating Procedure (SOP) No. 34 for Trace/ Low VOA – Blank Type Criteria Table

**Optional MS/MSD – Reference CLP SOM02.4, Exhibit D, VOCs Section Table 11 for Criteria – Not typically required for CLP in Region 2

***DMCs – Reference CLP SOM02.4, Exhibit D, VOCs Section Table 10 for Criteria

QAPP Worksheet #12b: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group TCL SVOCs/SOM02.4
Concentration Level Low/Medium (µg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Overall Precision	Field duplicates	≤40%RPD when SVOCs in both samples ≥ 5xCRQL otherwise ABS ≤ 2xCRQL
Precision	MS/MSD**	See Worksheet #28 for compound specific values
Accuracy	***DMCs; MS/MSD**	See Worksheet #28 for list of compound specific values and range of acceptable %Rs
Sensitivity	Method detection limit (MDL) verification or method blank	Results ≤ CRQL
	Data assessment	CRQLs meet project quantitation limit goals (PQLGs)
Completeness	Data assessment Verification and Completeness Checks	≥90 percent valid data versus total data collected and ≥90 percent planned data versus data collected See Worksheet #34

*Reference EPA Region 2 /Low/Medium Semi-volatile SOP shown on Worksheet #36 or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>)

**Optional MS/MSD – Reference CLP SOM02.4, Exhibit D, SVOCs Section Table 12 for Criteria – Not typically required for Region 2

***{DMCs} – Reference CLP SOM02.4, Exhibit D, SVOCs Section Table 11 for Criteria

QAPP Worksheet #12c: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group TCL Pesticides/SOM02.4
Concentration Level Low/Medium (µg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Overall Precision	Field duplicates	≤40%RPD when pesticides in both samples ≥ 5xCRQL, otherwise ABS ≤ 2xCRQL
Analytical accuracy/bias (contamination)	Method blank	No analyte > CRQL No target analyte concentrations ≥ ½ CRQL
Precision	MS/MSD**	See Worksheet #28 for compound specific values
Accuracy	***Laboratory control sample (LCS); MS/MSD** Surrogates (Table 10 of method)	See Worksheet #28 for the list of compound-specific values
Sensitivity	Method blank	Results ≤ CRQL
	Data assessment	CRQLs meet PQLGs or PALs at a minimum
Completeness	Data assessment Verification and Completeness Checks	≥90 percent valid data versus total data collected and ≥90 percent planned data versus data collected See Worksheet #34

*Reference EPA Region Low/Medium Pesticide Data Validation SOP on Worksheet # 36 or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>)

**MS/MSD – Reference CLP SOM02.4, Exhibit D, Pesticides Section Table 11 for Criteria

***LCS – Reference CLP SOM02.4, Exhibit D, Pesticides Section Table 12 for Criteria

QAPP Worksheet #12d: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group TCL PCBs/Aroclors/SOM02.4
Concentration Level Low/Medium (µg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Overall Precision	Field duplicates	≤40%RPD when PCBs in both samples ≥ 5xCRQL, otherwise ABS ≤ 2xQL
Analytical accuracy/bias (contamination)	Method blank	No analyte > CRQL No target analyte concentrations ≥ ½ CRQL
Precision	MS/MSD**	See Worksheet #28 for compound specific values
Accuracy	***LCS; MS/MSD** Surrogates (Table 6 of method)	See Worksheet #28 for the list of compound-specific values
Sensitivity	Method blank	Results ≤ CRQL
	Data assessment	CRQLs meet PQLGs or PALs at a minimum
Completeness	Data assessment Verification and Completeness Checks	≥90 percent valid data versus total data collected and ≥90 percent planned data versus data collected See Worksheet #34

*Reference EPA Region Low/Medium Aroclor Data Validation SOP on Worksheet # 36 or most recent revision <https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>

**MS/MSD – Reference CLP SOM02.4, Exhibit D, Table 7 for Criteria – Not typically required for Region 2

***LCS – Reference CLP SOM02.4, Exhibit D, Table 8 for Criteria

QAPP Worksheet #12e: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Metals – ISM02.4 – Inductively coupled plasma atomic emission spectroscopy (ICP-AES) (Total and dissolved)
Concentration Level Low/Medium (µg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicates *	≤40% RPD when both results ≥ 5xCRQL otherwise, ABS ≤ 2xCRQL The validation SOP requires qualification of results ≤20% RPD. For project purposes and data use, these criteria are satisfactory.
Precision	Laboratory duplicate sample **	≤ 20% RPD**
Accuracy	Matrix spike ***; LCS ****	75–125 %R; 70–130 %R (except Ag and Sb)
Comparability	Assessed during data quality assessment (DQA)	Comparable units, and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90% collection and analysis See Worksheet #34
Sensitivity/Accuracy	Field rinsate/method blanks assessed during data validation (DV) and DQA	≤ CRQLs (Worksheet #15 and laboratory SOP)

* Reference EPA ICP-AES Data Validation SOP or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>). More detailed QA/QC procedures for this analytical service are provided in Exhibit E of the SOW, which can be accessed at <https://www.epa.gov/clp/superfund-clp-analytical-statements-work-sows>

**Reference EPA CLP ISM02.4, Exhibit D of ICP-AES for Duplicate Sample Analysis, includes absolute difference criteria

***Reference EPA CLP ISM02.4, Exhibit D of ICP-AES for Spike Sample Analysis

****Reference EPA CLP ISM02.4, Exhibit D of ICP-AES for LCS Sample Criteria

QAPP Worksheet #12f: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Target analyte list (TAL) Metals /ISM02.4 - Inductively coupled plasma mass spectrophotometer (ICP-MS) (µg/L) (Total and dissolved)
Concentration Level Low/Medium (µg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Overall Precision	Field duplicates	≤40%RPD when both results ≥ 5xCRQL ABS ≤ 2xCRQL when either result ≤ 5xCRQL (¹ Note. Validation SOP requires qualification of results ≤20%RPD. For project purposes the above criteria are satisfactory)
Precision	Laboratory duplicate sample **	≤ 20%RPD**
Accuracy	Matrix spike ***; LCSW ****	75-125%R; 70-130%R (except Ag and Sb)
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Field rinsate / Method blanks assessed during DV and DQA	≤ CRQLs (WS#15 and laboratory SOP)

*Reference EPA Region 2 ICP-MS Data Validation SOP or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>) (include absolute difference criteria)

**Reference EPA CLP ISM02.4, Exhibit D of ICP-MS for Duplicate Sample Analysis

***Reference EPA CLP ISM02.4, Exhibit D of ICP-MS for Spike Sample Analysis

****Reference EPA CLP ISM02.4, Exhibit D of ICP-MS for aqueous LCS (LCSW) Analysis

QAPP Worksheet #12g: Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix
Analytical Group
Concentration Level

Aqueous
 TAL Total Cyanide (CN) – ISM02.4 – Spectrophotometer (Total and dissolved)
 Low (µg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicates	≤40% RPD when both results ≥ 5xCRQL ABS ≤ 2xCRQL when either result ≤ 5xCRQL Validation SOP requires qualification of results ≤20% RPD. For project purposes the above criteria are satisfactory.
Accuracy	Equipment blank	No analyte > CRQL
Precision	Laboratory duplicate sample **	≤ 20% RPD*
Accuracy	Matrix spike***	75–125 %R
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks assessed during DV and DQA	≤ CRQLs (Worksheet #15 and laboratory SOP)

* Reference EPA Region 2 Hg and CN Data Validation SOP or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>) (include absolute difference criteria)

**Reference EPA CLP ISM02.4, Exhibit D of Cyanide for Duplicate Sample Analysis

***Reference EPA CLP ISM02.4, Exhibit D of Cyanide for Spike Sample Analysis

QAPP Worksheet #12h: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group TAL –Total Mercury/ISM02.4 - Cold Vapor Atomic Absorption (CVAA) (Total and dissolved)
Concentration Level Low (µg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Overall Precision	Field duplicates	≤40%RPD when both results ≥ 5xCRQL ABS ≤ 2xCRQL when either result ≤ 5xCRQL
Precision	Laboratory duplicate sample **	≤ 20%RPD*
Accuracy	Matrix spike***	75-125%R
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks assessed during DV and DQA	≤ QLs (WS#15 and laboratory SOP)

* Reference EPA Region Hg Data Validation SOP or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>)
(include absolute difference criteria)

**Reference EPA CLP ISM02.4, Exhibit D of Mercury for Duplicate Sample Analysis

***Reference EPA CLP ISM02.4, Exhibit D of Mercury for Spike Sample Analysis

QAPP Worksheet #12i: Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Methylmercury/Brooks Applied Laboratories (SOP # BAL-3200 based on EPA 1630 Modified)
Concentration Level Trace

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicate	RPD \leq 40% when both results \geq 5xCRQL ABS \leq CRQL when either result \leq 5xCRQL
Accuracy	Laboratory duplicate	RPD \leq 35% for values \geq 5 MDL. No more than 35% of relative standard deviations (RSDs) $>$ 35%
Accuracy/Bias	MS/MSD	65-135 %R
Precision	MS/MSD	RPD \leq 35%
Accuracy	Ongoing Precision and Recovery Standard	67-133%R of certified value
Accuracy/ Representativeness	Temperature Blank Checks Data validation (DV)	0 to 6 °C
Comparability	Evaluated during DQA	Comparable units, and methods
Completeness	Assessed during DQA Verification and Completeness Checks	\geq 90 percent collection and analysis See Worksheet #34
Sensitivity/ accuracy	Equipment Blanks Method blanks (assessed during DV and DQA)	\leq QLs (WS #15) $<$ 0.0001 ng/L or \leq 5 MDLs

QAPP Worksheet #12j: Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Total organic carbon (TOC)/Wet Chemistry – TOC-carbon analyzer - EPA Method 415.2, 9060 or SM5310B
Concentration Level Low (mg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicates	≤40% RPD when both results ≥ 5xQL ABS ≤ 2xQL when either result ≤ 5xQL
Accuracy	Temperature blank	≤6°C
Precision	Laboratory duplicate sample	≤ 20% RPD for samples >5xQL; ± QL for samples <5xQL
Accuracy	Matrix Spike LCS	75–125 %R; 80–120 %R
Sensitivity	Method blank	≤ QL; detection limits (QLs) meet project goals (PQLGs)
Accuracy/Representativeness	Laboratory report/ DV	Holding times
Comparability	Data assessment	Comparable units, QLs, and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34

QAPP Worksheet #12k: Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Wet Chemistry-
DOC/POC - EPA Method 415.1¹
Concentration Level Low

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicate	RPD \leq 40% if values $>5xQL$; otherwise $ABS \leq 2xQL$
Accuracy/Bias	MS Recovery LCS Recovery	80-120%R 80-120%R or as stipulated in laboratory SOP
Precision	MS/LCS	RPD \leq 20%
Precision	Laboratory duplicate/DV	≤ 20 %RPD if values $>5xQL$; otherwise $ABS \leq 2xQL$
Accuracy	Method and Equipment Blanks	$<QL$
Accuracy/ Representativeness	Temperature Blank checks Data validation /DV	0 to 6 °C
Comparability	Data Quality Assessment	Comparable units, QLs and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/ Accuracy	Method blanks/Calibration Blank	$\leq QLs$
	Data Quality Assessment	Detection limits meet project goals

1. QAPP Worksheet # 23 provides more information on the sampling and analytical standard operating procedures (SOPs).

QAPP Worksheet #12I: Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Total suspended solids (TSS) – SM2540D
Concentration Level Low (mg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicates	RPD \leq 40% if values $>5 \times \text{QL}$; otherwise $\text{ABS} \leq \text{QL}$
Accuracy/Bias	Quality Control Sample (QCS) or laboratory fortified blank (LCS equivalent)	80–120 %R or as stipulated by manufacturer or laboratory
Accuracy/Representativeness	Temperature blank	0 to 6°C
Precision	Laboratory duplicate	$\leq 20\%$ RPD if values $>5 \times \text{QL}$; otherwise $\text{ABS} \leq 2 \times \text{QL}$
Comparability	Data assessment	Comparable units, QLs and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks	$\leq \text{QLs}$
Sensitivity	Data review	Detection limits (QLs) meet project goals (PQLGs)

QAPP Worksheet #12m: Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Total dissolved solids (TDS) – SM2540C
Concentration Level Low (mg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicates	RPD \leq 40% if values $>5xQL$; otherwise ABS $\leq 2xQL$
Accuracy/Bias	LCS or QCS	80–120 %R or as stipulated by manufacturer or laboratory
Precision	LCS or QCS	$\leq 20\%$ RPD
Accuracy/Representativeness	Temperature blank	0 to 6°C
Precision	Laboratory duplicate	$\leq 20\%$ RPD if values $>5xQL$; otherwise ABS $\leq 2xQL$
Sensitivity/Accuracy	Preparation blank/method blanks	$\leq QLs$

QAPP Worksheet #12n: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Wet Chemistry Anions by Ion chromatography (for chloride, sulfate, nitrate, phosphate) – Method EPA 300.0 or equivalent
Concentration Level Low (mg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicates	≤40% RPD ABS ≤ 2xQL when either result ≤ 5xQL
Accuracy	Equipment blank	No analyte > QL
Accuracy	Temperature blank	≤ 6°C
Precision	Laboratory duplicate	≤ 40% RPD
Sensitivity	Method/Preparation blank	No analyte > QL; detection limits meet project goals
Accuracy	Laboratory fortified blank	80–120 %R or laboratory in-house limits
	Matrix spike	75–125 %R or laboratory in-house limits
	Calibration standard verification	90–110 %R or laboratory in-house limits
Completeness	Assessed during DQA	≥ 90 percent collection and analysis
	Verification and Completeness Checks	See Worksheet #34
Comparability	Data review	Similar units (mg/L) and methods

QAPP Worksheet #12o: Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Wet Chemistry-Anions by Colorimetry; Spectrophotometry (for ammonia)—EPA 350.1
Concentration Level Low (mg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	≤40% RPD ABS ≤ 2xQL when either result ≤ 5xQL
Accuracy	Equipment blank	No analyte > QL
Accuracy	Temperature Blank	≤ 6 °C
Precision	Laboratory Duplicate Sample	≤ 40% RPD
Sensitivity	Method Blank	No analyte > QL; Detection limits meet project goals
Accuracy	Matrix Spike; LCS	75–125%R; 80-120%R
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Comparability	Data Review	Similar Units (mg/L)

QAPP Worksheet #12p: Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Aqueous
Analytical Group Wet Chemistry – Titration Alkalinity as Bicarbonate EPA 310.2 or SM2320¹
Concentration Level Low/Medium (mg/L)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicates	≤40% RPD ABS ≤ 2xQL when either result ≤ 5xQL
Accuracy	Equipment blank	No analyte > QL
Accuracy	Temperature blank	≤ 6°C
Precision	Laboratory Duplicate sample	≤ 40% RPD
Sensitivity	Method blank	No analyte > QL; detection limits meet project goals
Accuracy	LCS	80–120 %R
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Comparability	Data review	Similar units (mg/L)

1. Titrimetric analysis will be performed for alkalinity using SM 2320

QAPP Worksheet #12q: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group TCL VOCs/SOM02.4
Concentration Level Low/Medium (micrograms per kilogram [µg/kg])

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Overall Precision	Field duplicates	≤100%RPD for sediments; ≤60%RPD for soils ABS ≤ 2xCRQL when either result < 5xCRQL
Precision	MS/MSD**	%RPD – see Worksheet #28
Accuracy	***DMCs; MS/MSD**	Compound specific %Rs are on Worksheet #28
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks assessed during DV and DQA	≤ CRQLs (WS#15 and laboratory SOP)

*Reference EPA Region 2 Low/Medium VOCs Data Validation SOP shown on Worksheet #36 or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>)

**Optional MS/MSD – Reference CLP SOM02.4, Exhibit D, VOCs Section Table 11 for Criteria – Not typically required for Region 2

***(DMCs) – Reference CLP SOM02.4, Exhibit D, VOCs Section Tables 10 for Criteria

QAPP Worksheet #12r: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group TCL SVOCs/SOM02.4
Concentration Level Low/Medium (µg/kg)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Overall Precision	Field duplicates	≤100%RPD for sediments; ≤60%RPD for soils; ABS ≤ 2xCRQL when either results ≤ 5xCRQL
Precision	Laboratory duplicate; MS/MSD**	Worksheet #28 lists compound-specific RPDs
Accuracy	***DMCs; MS/MSD**	Worksheet #28 lists compound-specific %Rs
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks assessed during DV and DQA	≤ CRQLs (WS#15 and laboratory SOP)

*Reference EPA Region 2 Low/Medium SVOCs Data Validation SOP shown on Worksheet # 36 or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>)

**Optional MS/MSD – Reference CLP SOM02.4, Exhibit D, SVOCs Section Table 12 for Criteria – Not typically required for Region 2

*** (DMCs) – Reference CLP SOM02.4, Exhibit D, SVOCs Section Table 11 for Criteria

QAPP Worksheet #12s: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group TCL Pesticides/SOM02.4
Concentration Level Low/Medium (µg/kg)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicates	≤100%RPD for sediments; ≤60%RPD for soils ABS ≤ 2xCRQL when either result is ≤5xCRQL
Precision	MS/MSD**	See list of compound-specific RPDs and %Rs on Worksheet #28
Accuracy	LCS***	
	MS/MSD**	
	Surrogates****	
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks assessed during DV and DQA	≤ CRQLs (WS#15 and laboratory SOP)

*Reference EPA Region 2 Low/Medium Pesticide Data Validation SOP shown on Worksheet #36 or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>)

**MS/MSD – Reference CLP SOM02.4, Exhibit D, Pesticides Section, Table 11 for Criteria – Not typically required for Region 2

***LCS – Reference CLP SOM02.4, Exhibit D, Pesticides Section, Table 12 for Criteria

**** Surrogates – Reference CLP SOM02.4, Exhibit D, Pesticides Section, Table 10 for Criteria

QAPP Worksheet #12t: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group TCL PCBs/Aroclors/SOM02.4
Concentration Level Low/Medium (µg/kg)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Overall Precision	Field duplicates	≤100%RPD for sediments; ≤60%RPD for soils ABS ≤ 2xCRQL when either result is ≤5xCRQL
Precision	MS/MSD**	See list of compound-specific RPDs and %Rs on Worksheet #28
Accuracy	LCS***	
	MS/MSD**	
	Surrogates	
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks assessed during DV and DQA	≤ QLs (WS#15 and laboratory SOP)

*Reference EPA Region 2 Low/Medium PCB Data Validation SOP shown on Worksheet #36 or most recent revision <http://www.epa.gov/region2/qa/documents.htm>

**MS/MSD – Reference CLP SOM02.4, Exhibit D, Table 7 for Criteria – Not typically required for Region 2

***LCS – Reference CLP SOM02.4, Exhibit D, Table 8 for Criteria

**** Surrogates – Reference CLP SOM02.4, Exhibit D, Pesticides Section, Table 6 for Criteria

QAPP Worksheet #12u: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group Dioxins/Furans /HRSM01.2
Concentration Level Low (ng/kg)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates***	If both sample results $\geq 5 \times \text{CRQL}$ - $\text{RPD} \leq 100\% \text{RPD}$ for sediments; $\leq 60\% \text{RPD}$ for soils**** if either result $< 5 \times \text{CRQL}$, $\text{ABS} \leq 2 \times \text{CRQL}$
Accuracy	Method Blank	$< 1/2 \text{ CRQL}$, except OCDD/OCDF OCDD/OCDF must be $< 3 \times \text{CRQL}$
Accuracy	Labeled compounds in samples (internal standard)	17-185%R for labeled compounds in samples
Accuracy/Bias	LCS	63-170% R for dioxin/furan analytes 17-185%R for labeled compounds
Precision	LCS/LCSD	$\text{RPD} \leq 30\%$ [Advisory]
Accuracy	Temperature Blank	0 to 6 °C
Sensitivity	Equipment Rinsate Blanks/Method Blank	$\leq \text{CRQLs}$ **** DLs meet (PQLGs)****
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Comparability	Data Review	Similar Units (ng/kg)

*Analytical criteria are outlined in the CLP SOWs. If a subcontract laboratory is utilized, analytical criteria may be outlined in the laboratory SOWs and SOPs.

***Only the field duplicate results will be affected since low precision may be due to non-homogenous soils. Data qualifiers will be applied to the field duplicate samples only.

****See Worksheet # 15 for sensitivity requirements and CRQL values.

QAPP Worksheet #12v: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group TAL Metals/ISM02.4
Concentration Level ICP-AES (milligram per kilogram [mg/kg])

DQIs	QC Sample or Measurement Performance Activity*	Measurement Performance Criteria
Overall Precision	Field duplicates*	When both results $\geq 5 \times \text{CRQL}$, $\leq 100\% \text{RPD}$ for sediments; $\leq 60\% \text{RPD}$ for soils $\text{ABS} \leq 2 \times \text{CRQL}$ when either result $\leq 5 \times \text{CRQL}$ ⁽¹⁾ Note. Validation SOP requires qualification of results $\leq 50\% \text{RPD}$. For project purposes the above criteria are satisfactory)
Precision	Laboratory duplicate sample **	$\leq 35\% \text{RPD}^*$ (DV action based on this value)
Accuracy	Equipment blank*	No analyte > CRQL
Accuracy	Matrix spike***; LCS****	75-125 %R 70-130 %R (Sb and Ag 50-150%R)
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks assessed during DV and DQA	$\leq \text{CRQLs}$ (WS#15 and laboratory SOP)

* Reference EPA ICP-MS Data Validation SOP or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>).

More detailed QA/QC procedures for this analytical service are provided in Exhibit E of the SOW, which can be accessed at: <https://www.epa.gov/clp/epa-contract-laboratory-program-statement-work-inorganic-superfund-methods-multi-media-multi-1>

**Reference EPA CLP ISM02.4, Exhibit D of ICP-AES for Duplicate Sample Analysis, includes absolute difference criteria

***Reference EPA CLP ISM02.4, Exhibit D of ICP-AES for Spike Sample Analysis

****Reference EPA CLP ISM02.4, Exhibit D of ICP-AES for LCS Sample Criteria

QAPP Worksheet #12w: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group TAL Metals/ISM02.4
Concentration Level ICP-MS (mg/kg)

DQIs	QC Sample or Measurement Performance Activity*	Measurement Performance Criteria
Overall Precision	Field duplicates	$\leq 100\% \text{RPD}$ for sediments; $\leq 60\% \text{RPD}$ for soils when both results $\geq 5 \times \text{CRQL}$ $\text{ABS} \leq 2 \times \text{CRQL}$ when either result $\leq 5 \times \text{CRQL}$
Precision	Laboratory duplicate sample **	$\leq 35\% \text{RPD}^*$ (DV action based on this value)
Accuracy	Equipment blank*	No analyte > CRQL
Accuracy	Matrix spike***; LCS****	75-125%R 70-130%R
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks assessed during DV and DQA	$\leq \text{CRQLs}$ (WS#15 and laboratory SOP)

*Reference EPA ICP-MS Data Validation SOP or most recent revision revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>). More detailed QA/QC procedures for this analytical service are provided in Exhibit E of the SOW, which can be accessed at: <https://www.epa.gov/clp/epa-contract-laboratory-program-statement-work-inorganic-superfund-methods-multi-media-multi-1>

**Reference EPA CLP ISM02.4, Exhibit D of ICP-MS for Duplicate Sample Analysis

***Reference EPA CLP ISM02.4, Exhibit D of ICP-MS for Spike Sample Analysis

****Reference EPA CLP ISM02.4, Exhibit D of ICP-MS for LCS Sample Criteria

QAPP Worksheet #12x: Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group TAL –Total Cyanide/ISM02.4 or current method-Colorimeter or Spectrophotometer
Concentration Level Low (mg/kg)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicate	≤100%RPD for sediments; ≤60%RPD for soils when both results ≥ 5xCRQL ABS ≤ 2xCRQL when either result ≤5xCRQL
Accuracy	Equipment blank	No analyte > CQRL
Precision	Laboratory duplicate sample**	≤ 35% RPD; ABS ≤ 2xCRQL when either result ≤5xQL
Accuracy	Equipment blank*	No analyte > CRQL
Accuracy	MS***	75-125%R
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Field rinsate/ Method blanks assessed during DV and DQA	≤ CRQLs (WS#15 and laboratory SOP)

*Reference EPA Region 2 Hg and CN DV SOP or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>) (include ABS criteria)

**Reference EPA CLP ISM02.4, Exhibit D of Cyanide for Duplicate Sample Analysis

***Reference EPA CLP ISM02.4, Exhibit D of Cyanide for Spike Sample Analysis

QAPP Worksheet #12y: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group TAL –Total Mercury/ISM02.4 or current method
Concentration Level Cold Vapor Atomic Absorption (CVAA) (mg/kg)

DQIs	QC Sample or Measurement Performance Activity*	Measurement Performance Criteria
Overall Precision	Field duplicates	$\leq 100\% \text{RPD}$ for sediments; $\leq 60\% \text{RPD}$ for soils when both results $\geq 5 \times \text{CRQL}$ $\text{ABS} \leq 2 \times \text{CRQL}$ when either result $\leq 5 \times \text{CRQL}$ ⁽¹⁾ Note. The validation SOP requires qualification of results $\leq 50\% \text{RPD}$. For project purposes, the above criteria are satisfactory)
Precision	Laboratory duplicate sample **	$\leq 35\% \text{RPD}^*$ (DV action based on this value)
Accuracy	Equipment blank*	No analyte > CRQL
Accuracy	Matrix spike***	75-125%R
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Field rinsate/ Method blanks assessed during DV and DQA	$\leq \text{QLs}$ (WS#15 and laboratory SOP)

*Reference EPA Region 2 Hg and CN Data Validation SOP or most recent revision (<https://www.epa.gov/quality/managing-quality-environmental-data-epa-region-2>) (include absolute difference criteria)

**Reference EPA CLP ISM02.4, Exhibit D of Mercury for Duplicate Sample Analysis (page D-19) (include absolute difference criteria)

***Reference EPA CLP ISM02.4, Exhibit D of Mercury for Spike Sample Analysis (page D-18)

QAPP Worksheet #12z: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Sediment
Analytical Group Methylmercury/ BAL-3200/EPA 1630 Modified
Concentration Level Low

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field duplicates	≤60% RPD for sediments when both results ≥ 5xQL ABS ≤ 2xQL when either result ≤5xQL
Precision	Laboratory duplicate sample	RPD ≤ 35% for values ≥5 MDL. No more than 35% of RSDs >35%
Accuracy/Bias	MS/MSD	65-135%R
Precision	MS/MSD	RPD ≤ 35%
Accuracy	Ongoing precision and recovery (Standard Reference Material [SRM])	67-133%R of certified value
Accuracy/Representativeness	Temperature blank checks/data validation (DV)	0 to 6°C
Comparability	Assessed during DQA	Comparable units and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/Accuracy	Method blanks assessed during DV and DQA	≤ QLs (WS#15 and laboratory SOP)

QAPP Worksheet #12aa: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Sediment
Analytical Group 6 Step Selective Sequential Extractions for Mercury (BAL-3900, or equivalent) with Mercury Analysis (EPA 1631E, Appendix BAL-3101, or equivalent) (Includes volatile mercury analysis as the F0 step)
Concentration Level Variable

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Laboratory analytical duplicate sample	RPD < 35% for samples after sequential extraction; RPD < 30%; results < 5x the method reporting limit (MRL) and ± 2x the MRL of each other for soil samples without sequential extraction
Accuracy	Laboratory analytical spike sample	77-123% R for samples after sequential extraction; 75 -130 % R for samples without sequential extraction
Accuracy	LCS	70-130 %R
Sensitivity/Accuracy	Method Blank	≤ QLs and meets PAL on WS#15

QAPP Worksheet #12ab: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group Grain size/D6913 and D7928
Concentration Level NA (percent particle size)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Laboratory Duplicate Sample	≤ 40% RPD*

*The RPD will be calculated on a subset of the grain size fractions using the following formula. The percent retained will be used to determine the RPD.

RPD = $100 \times |X1 - X2| / (X1 + X2)$ where X1 and X2 are the reported results for selected fractions of sample and duplicate results.

QAPP Worksheet #12ac: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment

Analytical Group TOC/Lloyd Kahn Method

Concentration Level Low (mg/kg)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicates	≤60% RPD for sediments; ≤60%RPD for soils when both results ≥ 5xCRQL ABS ≤ 2xQL when either result ≤ 5xQL
Accuracy	Mid-Range calibration verification standard	80–120%
	Near detection Limit Standard	75–125%
Precision	Laboratory Duplicate	≤ 35% RPD
Accuracy/ Representativeness	Temperature Blank checks DV	0 to 6 °C
Comparability	Evaluated during Data Assessment	Comparable units, and methods
Completeness	Assessed during DQA Verification and Completeness Checks	≥ 90 percent collection and analysis See Worksheet #34
Sensitivity/ Representativeness	Method blanks/DV and DQA	≤ QLs

QAPP Worksheet #12ad: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Soil/Sediment
Analytical Group Moisture Content/ASTM D2216
Concentration Level NA (percent particle size)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Laboratory Duplicate Sample*	≤ 40% RPD

*Though the method cited does not require a laboratory duplicate sample, the performance of a laboratory duplicate sample will provide accuracy for this value. The accuracy in this value is important as it will allow for more accurate dry-weight correction of complex mercury data.

QAPP Worksheet #12ae: Measurement Performance Criteria
(UFP-QAPP Manual Section 2.6.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix Gas/Air (Solid Sorbent Tube)
Analytical Group Mercury/ NIOSH 6009
Concentration Level 0.01 to 0.5 mg/m³ (10-L sample)

DQIs	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Laboratory Duplicate Sample*	≤30% RPD
Analytical Accuracy/Bias (laboratory)	LCS	75-125%R
Analytical Precision	LCSD	<20% RPD
Overall Accuracy/Bias (Contamination)	Method Blank	No target compounds >RL
Sensitivity Qualitative	Method Blank MDL Standards	No target compounds > RL 80-120%R
Completeness	See Worksheet #37	See Worksheet #37

* Sorbent tube samples will be analyzed for mercury with NIOSH 6009.

QAPP Worksheet #13: Secondary Data Criteria and Limitations Table
(UFP-QAPP Manual Section 2.7)
(EPA 2106-G-05 Chapter 3: QAPP Elements for Evaluating Existing Data)

Data Type	Data Source	Data Use Relative to Current Project	Factors affecting the Reliability of Data and Limitations on Data Use
Chemical	Site Characterization Report, Troy Chemical Newark Manufacturing Plant. Geosyntec Consultants. November 18, 2016.	Results used to plan RI field work and select sample locations and analyses.	No known issues.
Topographic	United States Geologic Survey	Identification of surface water drainage pathways	No known issues.
Meteorological	National Weather Service	Estimations of seasonal fluctuations	Published data are available. No known limitations.

**QAPP Worksheet #14 and #16: Project Tasks and Schedule
(UFP-QAPP Manual Section 2.8.2)
(EPA 2106-G-05 Section 2.2.4)**

A summary of major project tasks is provided below. Field activities are anticipated to begin in November 2018 and conclude in June 2019.

CDM Smith Activity/Task	Description/ Duration	Deliverable	Deliverable Due Date*
Prepare QAPP	Create draft and final versions in preparation for RI field activities	QAPP	10/12/2018 (Final QAPP)
Field Investigation Mobilization	Coordinate with surveyor, driller and culture resources subcontractors; order equipment and bottleware - prepare Scribe files	No deliverable. Readiness checklist/ field planning meeting agenda document these activities	Prior to start of field program
Hydrogeological Assessment	November 2018 - February 2019	Field forms and logbooks (well assessment checklist)	1 day post completion of sampling
Sediment Sampling Program	January 2019 - February 2019	Field forms; validated data packages	1 day post completion of sampling; 42 days after sample receipt
Surface Water Sampling Program	Wet weather (February 2019) and dry weather (May 2019) - schedule subject to weather		1 day after completion of sampling; 42 days after sample receipt
Soil Sampling Program	January 2019 - February 2019		1 day after sampling; 42 days after sample receipt
Groundwater Sampling Program	February 2019 – May 2019		1 day post completion of sampling; 42 days after sample receipt
IDW Disposal	Coordinate with IDW subcontractor for sampling and analysis; complete off-site rule form	Waste characterization results; disposal documentation	2 weeks post completion of sampling
Demobilization	Return equipment; copy field logs; submit Scribe files to DM	None	NA
Data Validation	Verify QC and sample data results as per WS #36	DV reports	21 days after last data sample delivery group (SDG) received
Data Assessment	Assess data quality and usability of validated data as per WS #37	Data Usability/Quality Report	14 days after database review is complete and data hold released
Prepare RI Report	Create draft and final versions of report detailing nature and extent of contamination	RI Report	1/22/2020 (Final RI report)
HHRA	Create draft and final versions of report detailing potential threats to human health	HHRA Report	December 2019 (Final HHRA)
Ecological Risk Assessment	Create draft and final versions of report detailing ecological risk	SLERA Report	December 2019 (Final SLERA)

*Deliverable due dates may be moved pending unexpected delays during field work. IDW - Investigation derived waste

QAPP WORKSHEET # 15a
Aqueous Screening Criteria - VOCs - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health based Ground Water Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater PAL (µg/L)	Groundwater PQLG (µg/L)	CRQL - SOM02.4 Trace Water (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
1,1,1-Trichloroethane	71-55-6	30	200	30	8,000	30	10	0.5	5
1,1,2,2-Tetrachloroethane	79-34-5	1	NL	1	0.076	0.076	0.076	0.5	5
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NL	NL	NL	10,000	10,000	3,333	0.5	5
1,1,2-Trichloroethane	79-00-5	3	5	3	0.28	0.28	0.28	0.5	5
1,1-Dichloroethane	75-34-3	50	NL	50	2.8	2.8	0.93	0.5	5
1,1-Dichloroethene	75-35-4	2	7	1	280	1	0.5	0.5	5
1,2,3-Trichlorobenzene	87-61-6	NL	NL	NL	7	7	2.3	0.5	5
1,2,4-Trichlorobenzene	120-82-1	9	70	9	1.2	1.2	0.6	0.5	5
1,2-Dibromo-3-chloropropane	96-12-8	0.2	0.2	0.02	0.00033	0.00033	0.00033	0.5	5
1,2-Dibromoethane	106-93-4	0.05	0.05	0.0004	0.01	0.0004	0.0004	0.5	5
1,2-Dichlorobenzene	95-50-1	600	600	600	300	300	100	0.5	5
1,2-Dichloroethane	107-06-2	2	5	0.3	0.17	0.17	0.17	0.5	5
1,2-Dichloropropane	78-87-5	5	5	0.5	0.14	0.14	0.14	0.5	5
1,3-Dichlorobenzene	541-73-1	600	NL	600	NL	600	200	0.5	5
1,4-Dichlorobenzene	106-46-7	75	75	75	0.48	0.48	0.48	0.5	5
2-Butanone	78-93-3	NL	NL	300	5,600	300	100	5	10
2-Hexanone	591-78-6	NL	NL	NL	38	38	13	5	10
4-Methyl-2-pentanone	108-10-1	NL	NL	NL	6,300	6,300	2,100	5	10
Acetone	67-64-1	NL	NL	6,000	14,000	6,000	2,000	5	10
Benzene	71-43-2	1	5	0.2	0.46	0.20	0.2	0.5	5
Bromochloromethane	74-97-5	NL	NL	NL	83	83	28	0.5	5
Bromodichloromethane	75-27-4	80	80	0.60	0.13	0	0.13	0.5	5
Bromoform	75-25-2	80	80	4	3.3	3.3	1.1	0.5	5
Bromomethane	74-83-9	NL	NL	10	7.5	7.5	3	0.5	5
Carbon Disulfide	75-15-0	NL	NL	700	810	700	233	0.5	5

QAPP WORKSHEET # 15a
Aqueous Screening Criteria - VOCs - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health based Ground Water Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater PAL (µg/L)	Groundwater PQLG (µg/L)	CRQL - SOM02.4 Trace Water (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
Carbon Tetrachloride	56-23-5	2	5.00	0.4	0.46	0.40	0.4	0.5	5
Chlorobenzene	108-90-7	50	100	50	78	50	17	0.5	5
Chloroethane	75-00-3	NL	NL	NL	21,000	21,000	7,000	0.5	5
Chloroform	67-66-3	80	80	70	0.22	0.22	0.22	0.5	5
Chloromethane	74-87-3	NL	NL	NL	190	190	63	0.5	5
cis-1,2-Dichloroethene	156-59-2	70	70	70	36	36	12	0.5	5
cis-1,3-Dichloropropene	10061-01-5	NL	NL	NL	NL	N/A	N/A	0.5	5
Cyclohexane	110-82-7	NL	NL	NL	13,000	13,000	4,333	0.5	5
Dibromochloromethane	124-48-1	80	80	0.40	0.87	0.40	0.4	0.5	5
Dichlorodifluoromethane	75-71-8	NL	NL	1,000	200	200	67	0.5	5
Ethylbenzene	100-41-4	700	700	700	1.5	2	0.5	0.5	5
Isopropylbenzene	98-82-8	NL	NL	NL	450	450	150	0.5	5
m,p-Xylene*	108-38-3	1,000	10,000	NL	190	190	63	0.5	5
Methyl Acetate	79-20-9	NL	NL	7,000	20,000	7,000	2,333	0.5	5
Methyl tert-Butyl Ether	1634-04-4	70	NL	70	14	14	5	0.5	5
Methylcyclohexane	108-87-2	NL	NL	NL	NL	N/A	N/A	0.5	5
Methylene Chloride	75-09-2	3	5	3	11	3	1	0.5	5
o-Xylene**	95-47-6	1,000	10,000	1,000	190	190	63	0.5	5
Styrene	100-42-5	100	100	100	1,200	100	33	0.5	5
Tetrachloroethene	127-18-4	1	5	0.4	11	0.40	0.4	0.5	5
Toluene	108-88-3	1,000	1,000	600	1,100	600	200	0.5	5
trans-1,2-Dichloroethene	156-60-5	100	100	100	360	100	33	0.5	5
trans-1,3-Dichloropropene	10061-02-6	NL	NL	NL	NL	N/A	N/A	0.5	5
Trichloroethene	79-01-6	1	5	1	0.49	0.49	0.49	0.5	5

QAPP WORKSHEET # 15a
Aqueous Screening Criteria - VOCs - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health based Ground Water Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater PAL (µg/L)	Groundwater PQLG (µg/L)	CRQL - SOM02.4 Trace Water (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
Trichlorofluoromethane	75-69-4	NL	NL	2000	5,200	2000	667	0.5	5
Vinyl Chloride	75-01-4	2	2	0.08	0.019	0.019	0.019	0.5	5
Xylenes (Total)	1330-20-7	1,000	10,000	1,000	190	190	190	NL	NL

Notes:

1. PALs were selected as the minimum value presented in a through d below.

(a) New Jersey Drinking Water Standards, February 10, 2009 (<http://www.nj.gov/dep/standards/drinking%20water.pdf>), downloaded May 13, 2017.

(b) EPA National Primary Drinking Water Standards, EPA 816-F-09-0004, May 2009. (https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf)

(c) New Jersey Ground Water Quality Standards Class IIA (N.J.A.C. 7:9C), March 2014. (http://www.nj.gov/dep/rules/rules/njac7_9c.pdf)

(d) EPA Human health-based screening – RSL Tapwater (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus noncancer endpoints was selected.

(http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MAs for VOCs, as they are not the considered the primary compounds of concern.

*Xylene (total) was used for m,p-xylene PAL criteria. M-xylene and p-xylene are reported as one compound under SOM02.4.

** Xylene (total) was used for o-xylene PAL criteria.

CAS - Chemical Abstracts Service

EPA - Environmental Protection Agency

CLP - contract laboratory program

CRQL - contract required quantitation limit

MA - modified analysis

N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection

NJMCL - New Jersey maximum concentration level

NL - not listed

NJ GWQC - New Jersey Groundwater Quality Criteria

PAL - project action limit

PQLG - project quantitation limit goal

RSL - regional screening level

VOC - volatile organic compound

µg/L - microgram per liter

QAPP WORKSHEET # 15b
Aqueous Screening Criteria - VOCs - Surface Water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic) [a]	National Recommended Water Quality Criteria (Chronic) [b]	EPA Region 3 (EPA3ECO) [c]	NJDEP Surface Water Quality Criteria for Fresh Water [d]	National Recommended Water Quality Criteria [e]	Surface Water PAL (µg/L)	Surface Water PQLG (µg/L)	CRQL - SOM02.4 Trace Water (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
1,1,1-Trichloroethane	71-55-6	76	NL	11	120	NL	11	3.7	0.5	5
1,1,2,2-Tetrachloroethane	79-34-5	380	NL	610	4.7	0.17	0.17	0.17	0.5	5
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
1,1,2-Trichloroethane	79-00-5	500	NL	1200	13	0.59	0.59	0.5	0.5	5
1,1-Dichloroethane	75-34-3	NL	NL	47	NL	NL	47	16	0.5	5
1,1-Dichloroethene	75-35-4	65	NL	25	4.7	330	4.7	1.6	0.5	5
1,2,3-Trichlorobenzene	87-61-6	NL	NL	8	NL	NL	8	2.7	0.5	5
1,2,4-Trichlorobenzene	120-82-1	30	NL	24	21	35	21	7	0.5	5
1,2-Dibromo-3-chloropropane	96-12-8	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
1,2-Dibromoethane	106-93-4	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
1,2-Dichlorobenzene	95-50-1	14	NL	0.7	2000	420	0.7	0.5	0.5	5
1,2-Dichloroethane	107-06-2	910	NL	100	0.29	0.38	0.29	0.29	0.5	5
1,2-Dichloropropane	78-87-5	360	NL	NL	0.5	0.5	0.5	0.5	0.5	5
1,3-Dichlorobenzene	541-73-1	38	NL	150	2200	320	38	13	0.5	5
1,4-Dichlorobenzene	106-46-7	9.4	NL	26	550	63	9.4	3.1	0.5	5
2-Butanone	78-93-3	NL	NL	14000	NL	NL	14,000	4,667	5	10
2-Hexanone	591-78-6	NL	NL	99	NL	NL	99	33	5	10
4-Methyl-2-pentanone	108-10-1	NL	NL	170	NL	NL	170	57	5	10
Acetone	67-64-1	NL	NL	1500	NL	NL	1,500	500	5	10
Benzene	71-43-2	114	NL	370	0.15	2.2	0.15	0.15	0.5	5
Bromochloromethane	74-97-5	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
Bromodichloromethane	75-27-4	NL	NL	NL	0.55	0.55	0.55	0.5	0.5	5
Bromoform	75-25-2	230	NL	320	4.3	4.3	4.3	1.4	0.5	5
Bromomethane	74-83-9	16	NL	NL	47	47	16	5.3	0.5	5
Carbon Disulfide	75-15-0	NL	NL	0.92	NL	NL	0.92	0.7	0.5	5
Carbon Tetrachloride	56-23-5	240	NL	13.3	0.33	0.23	0.23	0.23	0.5	5
Chlorobenzene	108-90-7	47	NL	1.3	210	130	1.3	0.5	0.5	5
Chloroethane	75-00-3	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
Chloroform	67-66-3	140	NL	1.8	68	5.7	1.8	0.6	0.5	5
Chloromethane	74-87-3	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
cis-1,2-Dichloroethene	156-59-2	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
cis-1,3-Dichloropropene	10061-01-5	NL	NL	0.055	0.34	0.34	0.055	0.055	0.5	5
Cyclohexane	110-82-7	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
Dibromochloromethane	124-48-1	NL	NL	NL	0.4	0.4	0.4	0.4	0.5	5
Dichlorodifluoromethane	75-71-8	NL	NL	NL	NL	NL	N/A	N/A	0.5	5

QAPP WORKSHEET # 15b
Aqueous Screening Criteria - VOCs - Surface Water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic) [a]	National Recommended Water Quality Criteria (Chronic) [b]	EPA Region 3 (EPA3ECO) [c]	NJDEP Surface Water Quality Criteria for Fresh Water [d]	National Recommended Water Quality Criteria [e]	Surface Water PAL (µg/L)	Surface Water PQLG (µg/L)	CRQL - SOM02.4 Trace Water (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
Ethylbenzene	100-41-4	14	NL	90	530	530	14	4.7	0.5	5
Isopropylbenzene	98-82-8	NL	NL	2.6	NL	NL	2.6	0.87	0.5	5
m,p-Xylene*	108-38-3	27	13	13	NL	NL	13	4.3	0.5	5
Methyl Acetate	79-20-9	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
Methyl tert-Butyl Ether	1634-04-4	51000	NL	11070	70	NL	70	23	0.5	5
Methylcyclohexane	108-87-2	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
Methylene Chloride	75-09-2	940	NL	98.1	2.5	4.6	2.5	0.8	0.5	5
o-Xylene**	95-47-6	27	13	13	NL	NL	13	4.3	0.5	5
Styrene	100-42-5	32	NL	72	NL	NL	32	11	0.5	5
Tetrachloroethene	127-18-4	45	NL	111	0.34	0.69	0.34	0.34	0.5	5
Toluene	108-88-3	253	NL	2	1300	1300	2	0.7	0.5	5
trans-1,2-Dichloroethene	156-60-5	970	NL	970	590	140	140	47	0.5	5
trans-1,3-Dichloropropene	10061-02-6	NL	NL	0.055	0.34	0.34	0.055	0.055	0.5	5
Trichloroethene	79-01-6	47	NL	21	1	2.5	1	0.5	0.5	5
Trichlorofluoromethane	75-69-4	NL	NL	NL	NL	NL	N/A	N/A	0.5	5
Vinyl Chloride	75-01-4	930	NL	930	0.082	0.025	0.025	0.025	0.5	5
Xylenes (Total)	1330-20-7	27	NL	13	NL	NL	13	13	NL	NL

Notes:

1. Surface water PALs were selected as the minimum value presented in a through e below.

(a) NJDEP Surface Water Quality Standards: Ecological Screening Criteria (Chronic), October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)(b) EPA National Recommended Aquatic Life Criteria table based on Freshwater CCC (chronic) values,
Accessed May 2017 (<http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm>)(c) EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks, July 2006
https://www.epa.gov/sites/production/files/2015-09/documents/r3_btag_fw_benchmarks_07-06.pdf(d) NJDEP Surface Water Quality Standards: Human Health Criteria, October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)(e) EPA National Recommended Water Quality Criteria, Human Health for the consumption of water and organism
Accessed May 2017 (<https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table>)**Bolded** values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MAs for VOCs, as they are not the considered the primary compounds of concern.

*Xylene (total) was used for m,p-xylene PAL criteria. M-xylene and p-xylene are reported as one compound under SOM02.4.

** Xylene (total) was used for o-xylene PAL criteria.

CAS - Chemical Abstracts Service

EPA - Environmental Protection Agency

CLP - contract laboratory program

CRQL - contract required quantitation limit

MA - modified analysis

N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection

NL - not listed

NJ GWQC - New Jersey Groundwater Quality Criteria

PAL - project action limit

PQLG - project quantitation limit goal

RSL - regional screening level

VOC - volatile organic compound

µg/L - microgram per liter

QAPP WORKSHEET # 15c
Aqueous Screening Criteria - SVOCs - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health-based Ground Water Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater Screening Criteria (µg/L)	Groundwater PAL (µg/L)	Groundwater PQLG (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
1,1'-Biphenyl	92-52-4	NL	NL	400	0.83	400	1	1	5
1,4-Dioxane	123-91-1	NL	NL	NL	0.46	0.46	0.46	0.46	2
1,2,4,5-Tetrachlorobenzene	95-94-3	NL	NL	NL	1.7	2	1.7	1.7	5
2,2'-oxybis(1-Chloropropane)	108-60-1	NL	NL	300	710	300	300	100	10
2,3,4,6-Tetrachlorophenol	58-90-2	NL	NL	NL	240	240	240	80	5
2,4,5-Trichlorophenol	95-95-4	NL	NL	700	1,200	700	700	233	5
2,4,6-Trichlorophenol	88-06-2	NL	NL	1	4.1	1	1	1	5
2,4-Dichlorophenol	120-83-2	NL	NL	20	46	20	20	6.7	5
2,4-Dimethylphenol	105-67-9	NL	NL	100	360	100	100	33	5
2,4-Dinitrophenol	51-28-5	NL	NL	10	39	10	10	10	10
2,4-Dinitrotoluene	121-14-2	NL	NL	NA	0.24	0.24	0.24	0.24	5
2,6-Dinitrotoluene	606-20-2	NL	NL	NA	0.049	0.049	0.049	0.049	5
2-Chloronaphthalene	91-58-7	NL	NL	NL	750	750	750	250	5
2-Chlorophenol	95-57-8	NL	NL	40	91	40	40	13	5
2-Methylnaphthalene	91-57-6	NL	NL	30	36	30	30	10	5
2-Methylphenol	95-48-7	NL	NL	NA	930	930	930	310	10
2-Nitroaniline	88-74-4	NL	NL	NA	190	190	190	63	5
2-Nitrophenol	88-75-5	NL	NL	NL	NL	N/A	N/A	N/A	5
3,3'-Dichlorobenzidine	91-94-1	NL	NL	0.08	0.13	0.08	0.08	0.08	10
3-Methylphenol	108-39-4	NL	NL	NL	930	930	930	310	5
3-Nitroaniline	99-09-2	NL	NL	NL	NL	NL	N/A	N/A	10
4,6-Dinitro-2-methylphenol	534-52-1	NL	NL	0.7	2	0.7	0.7	0.7	10
4-Bromophenyl-phenylether	101-55-3	NL	NL	NL	NL	NL	N/A	N/A	5
4-Chloro-3-methylphenol	59-50-7	NL	NL	NL	1,400	1,400	1,400	467	5
4-Chloroaniline	106-47-8	NL	NL	NL	0.37	0.37	0.37	0.37	10
4-Chlorophenyl-phenyl ether	7005-72-3	NL	NL	NL	NL	NL	N/A	N/A	5
4-Methylphenol	106-44-5	NL	NL	NA	1,900	1,900	1,900	633	10
4-Nitroaniline	100-01-6	NL	NL	NL	3.8	3.8	3.8	3.8	10
4-Nitrophenol	100-02-7	NL	NL	NL	NL	NL	N/A	N/A	10
Acenaphthene	83-32-9	NL	NL	400	530	400	400	133	5
Acenaphthylene	208-96-8	NL	NL	NA	NL	NL	N/A	N/A	5
Acetophenone	98-86-2	NL	NL	700	1,900	700	700	233	10
Anthracene	120-12-7	NL	NL	2,000	1,800	2,000	1,800	600	5
Atrazine	1912-24-9	3	3	3	0.3	3.0	0.3	0.3	10
Benzaldehyde	100-52-7	NL	NL	NA	19	19	19	19	10
Benzo(a)anthracene	56-55-3	NL	NL	0.05	0.03	0.05	0.03	0.03	5
Benzo(a)pyrene	50-32-8	0.2	0.2	0.005	0.025	0.2	0.005	0.005	0.1
Benzo(b)fluoranthene	205-99-2	NL	NL	0.05	0.25	0.05	0.05	0.05	0.1
Benzo(g,h,i)perylene	191-24-2	NL	NL	NA	NL	NL	N/A	N/A	5
Benzo(k)fluoranthene	207-08-9	NL	NL	0.5	2.5	0.5	0.5	0.17	0.1
bis(2-Chloroethoxy) methane	111-91-1	NL	NL	NL	59	59	59	20	5
bis(2-Chloroethyl) ether	111-44-4	NL	NL	0.03	0.014	0.03	0.014	0.014	10
bis-(2-Ethylhexyl)phthalate	117-81-7	6	6	2	5.6	6	2	2	5
Butylbenzylphthalate	85-68-7	NL	NL	100	16	100	16	5	5
Caprolactam	105-60-2	NL	NL	3,500	9,900	3,500	3,500	1,167	10
Carbazole	86-74-8	NL	NL	NA	NL	NL	N/A	N/A	10
Chrysene	218-01-9	NL	NL	5	25	5	5	5	5
Dibenzo(a,h)anthracene	53-70-3	NL	NL	0.005	0.025	0.005	0.005	0.005	0.1
Dibenzofuran	132-64-9	NL	NL	NL	7.9	7.9	7.9	5	5
Diethylphthalate	84-66-2	NL	NL	6,000	15,000	6,000	6,000	2,000	5

QAPP WORKSHEET # 15c
Aqueous Screening Criteria - SVOCs - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health-based Ground Water Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater Screening Criteria (µg/L)	Groundwater PAL (µg/L)	Groundwater PQLG (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
Dimethylphthalate	131-11-3	NL	NL	NL	NL	NL	N/A	N/A	5
Di-n-butylphthalate	84-74-2	NL	NL	700	900	700	700	233	5
Di-n-octylphthalate	117-84-0	NL	NL	100	200	100	100	33	10
Fluoranthene	206-44-0	NL	NL	300	800	300	300	100	10
Fluorene	86-73-7	NL	NL	300	290	300	290	97	5
Hexachlorobenzene	118-74-1	1	1	0.02	0.0098	1	0.0098	0.0098	5
Hexachlorobutadiene	87-68-3	NL	NL	0.4	0.14	0.4	0.14	0.14	5
Hexachlorocyclopentadiene	77-47-4	50	50	40	0.41	50	0.41	0.41	10
Hexachloroethane	67-72-1	NL	NL	2	0.33	2	0.33	0.33	5
Indeno(1,2,3-cd)pyrene	193-39-5	NL	NL	0.05	0.25	0.05	0.05	0.05	0.1
Isophorone	78-59-1	NL	NL	40	78	40	40	13	5
Naphthalene	91-20-3	300	NL	300	0.17	300	0.17	0.17	5
Nitrobenzene	98-95-3	NL	NL	4	0.14	4	0.14	0.14	5
N-Nitroso-di-n-propylamine	86-30-6	NL	NL	7	12	7	7	5	5
N-Nitrosodiphenylamine	621-64-7	NL	NL	0.005	0.011	0.005	0.005	0.005	5
Pentachlorophenol	87-86-5	1	1	0.3	0.041	1	0.041	0.5	0.2
Phenanthrene	85-01-8	NL	NL	NA	NL	NL	N/A	N/A	5
Phenol	108-95-2	NL	NL	2,000	5,800	2,000	2,000	667	10
Pyrene	129-00-0	NL	NL	200	120	200	120	40	5

Notes:

- PALs were selected as the minimum value presented in a through d below.
 - New Jersey Drinking Water Standards, February 10, 2009 (<http://www.nj.gov/dep/standards/drinking%20water.pdf>), downloaded May 13, 2017.
 - EPA National Primary Drinking Water Standards, EPA 816-F-09-0004, May 2009. (https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf)
 - New Jersey Ground Water Quality Standards Class IIA (N.J.A.C. 7:9C), March 2014. (http://www.nj.gov/dep/rules/rules/njac7_9c.pdf)
 - EPA Human health-based screening – RSL Tapwater (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus noncancer endpoints was selected. (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MAs for SVOCs, as they are not the considered the primary compounds of concern.

CAS - Chemical Abstracts Service	NL - not listed
EPA - Environmental Protection Agency	NJMCL - New Jersey maximum concentration level
CLP - contract laboratory program	PAL - project action limit
CRQL - contract required quantitation limit	PQLG - project quantitation limit goal
MA - modified analysis	RSL - regional screening level
N/A - not applicable	SVOC - semivolatile organic compounds
NJDEP - New Jersey Department of Environmental Protection	µg/L - microgram per liter

QAPP WORKSHEET # 15d
Aqueous Screening Criteria - SVOCs - Surface Water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic) [a]	National Recommended Water Quality Criteria (Chronic) [b]	EPA Region 3 (EPA3ECO) [c]	NJDEP Surface Water Quality Criteria for Fresh Water [d]	National Recommended Water Quality Criteria [e]	Surface Water PAL (µg/L)	Surface Water PQLG (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
1,1'-Biphenyl	92-52-4	NL	NL	14	NL	NL	14	5	5
1,4-Dioxane	123-91-1	NL	NL	NL	NL	NL	N/A	N/A	2
1,2,4,5-Tetrachlorobenzene	95-94-3	3	NL	3	0.97	0.97	0.97	0.97	5
2,2'-oxybis(1-Chloropropane)	108-60-1	NL	NL	NL	1,400	1,400	1,400	467	10
2,3,4,6-Tetrachlorophenol	58-90-2	NL	NL	1.2	NL	NL	1.2	1.2	5
2,4,5-Trichlorophenol	95-95-4	NL	NL	NL	1,800	1,800	1,800	600	5
2,4,6-Trichlorophenol	88-06-2	4.9	NL	4.9	0.58	1.4	0.58	0.58	5
2,4-Dichlorophenol	120-83-2	11	NL	11	77	77	11	5	5
2,4-Dimethylphenol	105-67-9	100	NL	NL	380	380	100	33	5
2,4-Dinitrophenol	51-28-5	19	NL	NL	69	69	19	10	10
2,4-Dinitrotoluene	121-14-2	44	NL	44	0.11	0.11	0.11	0.11	5
2,6-Dinitrotoluene	606-20-2	NL	NL	81	NL	NL	81	27	5
2-Chloronaphthalene	91-58-7	0.396	NL	NL	1,000	1,000	0.396	0.396	5
2-Chlorophenol	95-57-8	24	NL	24	81	81	24	8	5
2-Methylnaphthalene	91-57-6	330	NL	4.7	NL	NL	4.7	4.7	5
2-Methylphenol	95-48-7	NL	NL	13	NL	NL	13	10	10
2-Nitroaniline	88-74-4	NL	NL	NL	NL	NL	N/A	N/A	5
2-Nitrophenol	88-75-5	NL	NL	1920	NL	NL	1920	640	5
3,3'-Dichlorobenzidine	91-94-1	4.5	NL	4.5	0.021	0.021	0.021	0.021	10
3-Methylphenol	108-39-4	NL	NL	NL	NL	NL	N/A	N/A	5
3-Nitroaniline	99-09-2	NL	NL	NL	NL	NL	N/A	N/A	10
4,6-Dinitro-2-methylphenol	534-52-1	NL	NL	NL	13	13	13	10	10
4-Bromophenyl-phenylether	101-55-3	NL	NL	1.5	NL	NL	1.5	1.5	5
4-Chloro-3-methylphenol	59-50-7	NL	NL	NL	NL	NL	N/A	N/A	5
4-Chloroaniline	106-47-8	NL	NL	232	NL	NL	232	77	10
4-Chlorophenyl-phenyl ether	7005-72-3	NL	NL	NL	NL	NL	N/A	N/A	5
4-Methylphenol	106-44-5	NL	NL	543	NL	NL	543	181	10
4-Nitroaniline	100-01-6	NL	NL	NL	NL	NL	N/A	N/A	10
4-Nitrophenol	100-02-7	60	NL	60	NL	NL	60	20	10
Acenaphthene	83-32-9	38	NL	5.8	670	670	5.8	5	5
Acenaphthylene	208-96-8	4840	NL	NL	NL	NL	4840	1613	5
Acetophenone	98-86-2	NL	NL	NL	NL	NL	N/A	N/A	10
Anthracene	120-12-7	0.35	NL	0.012	8,300	8,300	0.012	0.012	5
Atrazine	1912-24-9	NL	NL	1.8	NL	NL	1.8	1.8	10
Benzaldehyde	100-52-7	NL	NL	NL	NL	NL	N/A	N/A	10
Benzo(a)anthracene	56-55-3	0.025	NL	0.018	0.038	0.0038	0.0038	0.0038	5
Benzo(a)pyrene	50-32-8	0.014	NL	0.015	0.0038	0.0038	0.0038	0.0038	0.1

QAPP WORKSHEET # 15d
Aqueous Screening Criteria - SVOCs - Surface Water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic) [a]	National Recommended Water Quality Criteria (Chronic) [b]	EPA Region 3 (EPA3ECO) [c]	NJDEP Surface Water Quality Criteria for Fresh Water [d]	National Recommended Water Quality Criteria [e]	Surface Water PAL (µg/L)	Surface Water PQLG (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
Benzo(b)fluoranthene	205-99-2	9.07	NL	NL	0.038	0.0038	0.0038	0.0038	0.1
Benzo(g,h,i)perylene	191-24-2	7.64	NL	NL	NL	NL	7.64	5	5
Benzo(k)fluoranthene	207-08-9	NL	NL	NL	0.38	0.0038	0.0038	0.0038	0.1
bis(2-Chloroethoxy) methane	111-91-1	NL	NL	NL	NL	NL	N/A	N/A	5
bis(2-Chloroethyl) ether	111-44-4	1900	NL	NL	0.03	0.03	0.03	0.03	10
bis-(2-Ethylhexyl)phthalate	117-81-7	0.3	NL	16	1.2	1.2	0.3	0.3	5
Butylbenzylphthalate	85-68-7	23	NL	19	150	1500	19	6.3	5
Caprolactam	105-60-2	NL	NL	NL	NL	NL	N/A	N/A	10
Carbazole	86-74-8	NL	NL	NL	NL	NL	N/A	N/A	10
Chrysene	218-01-9	NL	NL	NL	3.8	0.0038	0.0038	0.0038	5
Dibenzo(a,h)anthracene	53-70-3	NL	NL	NL	0.0038	0.0038	0.0038	0.0038	0.1
Dibenzofuran	132-64-9	NL	NL	3.7	NL	NL	3.7	3.7	5
Diethylphthalate	84-66-2	110	NL	210	17,000	17,000	110	37	5
Dimethylphthalate	131-11-3	NL	NL	NL	NL	270,000	270,000	90,000	5
Di-n-butylphthalate	84-74-2	9.7	NL	19	2,000	2,000	9.7	5	5
Di-n-octylphthalate	117-84-0	NL	NL	22	NL	NL	22	10	10
Fluoranthene	206-44-0	1.9	NL	0.04	130	130	0.04	0.04	10
Fluorene	86-73-7	19	NL	3	1,100	1,100	3	3	5
Hexachlorobenzene	118-74-1	0.0003	NL	0.0003	0.00028	0.00028	0.00028	0.00028	5
Hexachlorobutadiene	87-68-3	0.053	NL	1.3	0.44	0.44	0.053	0.053	5
Hexachlorocyclopentadiene	77-47-4	77	NL	NL	40	40	40	13	10
Hexachloroethane	67-72-1	8	NL	12	1.4	1.4	1.4	1.4	5
Indeno(1,2,3-cd)pyrene	193-39-5	4.31	NL	NL	0.038	0.0038	0.0038	0.0038	0.1
Isophorone	78-59-1	920	NL	NL	35	35	35	12	5
Naphthalene	91-20-3	13	NL	1.1	NL	NL	1.1	1.1	5
Nitrobenzene	98-95-3	220	NL	NL	17	17	17	5.7	5
N-Nitroso-di-n-propylamine	86-30-6	NL	NL	210	3.3	3.3	3.3	3.3	5
N-Nitrosodiphenylamine	621-64-7	NL	NL	NL	0.005	0.005	0.005	0.005	5
Pentachlorophenol	87-86-5	15	15	0.5	0.27	0.27	0.27	0.2	0.2
Phenanthrene	85-01-8	3.6	NL	0.4	NL	NL	0.4	0.4	5
Phenol	108-95-2	180	NL	4	10,000	10,000	4	4	10

QAPP WORKSHEET # 15d
Aqueous Screening Criteria - SVOCs - Surface Water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All units µg/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic) [a]	National Recommended Water Quality Criteria (Chronic) [b]	EPA Region 3 (EPA3ECO) [c]	NJDEP Surface Water Quality Criteria for Fresh Water [d]	National Recommended Water Quality Criteria [e]	Surface Water PAL (µg/L)	Surface Water PQLG (µg/L)	CRQL - SOM02.4 Low Water (µg/L)
Pyrene	129-00-0	0.3	NL	0.025	830	830	0.025	0.025	5

Notes:

1. Surface water PALs were selected as the minimum value presented in a through e below.

- (a) NJDEP Surface Water Quality Standards: Ecological Screening Criteria (Chronic), October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)
- (b) EPA National Recommended Aquatic Life Criteria table based on Freshwater CCC (chronic) values,
Accessed May 2017 (<http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm>)
- (c) EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks, July 2006
https://www.epa.gov/sites/production/files/2015-09/documents/r3_btag_fw_benchmarks_07-06.pdf
- (d) NJDEP Surface Water Quality Standards: Human Health Criteria, October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)
- (e) EPA National Recommended Water Quality Criteria, Human Health for the consumption of water and organism
Accessed May 2017 (<https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table>)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MAs for SVOCs, as they are not the considered the primary compounds of concern.

CAS - Chemical Abstracts Service
EPA - Environmental Protection Agency
CLP - contract laboratory program
CRQL - contract required quantitation limit
MA - modified analysis

NJDEP - New Jersey Department of Environmental Protection
NJ GWQC - New Jersey Groundwater Quality Criteria
N/A - not applicable
NL - not listed
PAL - project action limit

QAPP WORKSHEET # 15e
Aqueous Screening Criteria - Inorganics - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health based Ground Water Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater PAL (µg/L)	Groundwater PQLG (µg/L)	CRQL - ISM02.4 ICP- MS (µg/L)
Metals - ISM02.4								
Aluminum	7429-90-5	200	NL	200	20,000	200	67	20
Antimony	7440-36-0	6	6	6	7.8	6.00	2	2
Arsenic	7440-38-2	5	10	0.02	0.052	0.02	0.02	1
Barium	7440-39-3	2,000	2,000	6,000	3,800	2,000	667	10
Beryllium	7440-41-7	4	4	1	25	1	1	1
Cadmium	7440-43-9	5	5	4	NL	4	1	1
Calcium	7440-70-2	NL	NL	NL	NL	N/A	500	500
Chromium	18540-29-9	100	100	NL	0.035	0.035	0.035	2
Cobalt	7440-48-4	NL	NL	100	6	6	2	1
Copper	7440-50-8	1,300	1,300	1,300	800	800	267	2
Cyanide	57-12-5	200	200	100	1.5	1.5	1.5	10
Iron	7439-89-6	300	NL	NL	14,000	300	300	500
Lead	7439-92-1	15	15	5	15	5	1.67	1
Magnesium	7439-95-4	NL	NL	NL	NL	N/A	N/A	500
Manganese	7439-96-5	50	NL	50	NL	50	17	1
Mercury	7439-97-6	2	0.002	2	0.63	0.002	0.002	500
Nickel	7440-02-0	NL	NL	100	390	100	33	1
Potassium	7440-09-7	NL	NL	NL	NL	N/A	500	500
Selenium	7782-49-2	50	50	40	100	40	13	5
Silver	7440-22-4	100	NL	40	94	40	13	1
Sodium	7440-23-5	50,000	NL	NL	NL	50,000	16,667	500
Thallium	7440-28-0	2	2	0.5	0.2	0.2	0.2	1

QAPP WORKSHEET # 15e
Aqueous Screening Criteria - Inorganics - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health based Ground Water Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater PAL (µg/L)	Groundwater PQLG (µg/L)	CRQL - ISM02.4 ICP- MS (µg/L)
Vanadium	7440-62-2	NL	NL	NA	86	86	29	5
Zinc	7440-66-6	5,000	NL	2,000	6,000	2,000	667	2

Notes:

1. PALs were selected as the minimum value presented in a through d below.

(a) New Jersey Drinking Water Standards, February 10, 2009 (<http://www.nj.gov/dep/standards/drinking%20water.pdf>), downloaded May 13, 2017.

(b) EPA National Primary Drinking Water Standards, EPA 816-F-09-0004, May 2009. (https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf)

(c) New Jersey Ground Water Quality Standards Class IIA (N.J.A.C. 7:9C), March 2014. (http://www.nj.gov/dep/rules/rules/njac7_9c.pdf)

(d) EPA Human health-based screening – RSL Tapwater (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus noncancer endpoints was selected.

(http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will request the existing CLP MAs for mercury (highlighted), as it is considered the primary compound of concern.

If no MAs exist to meet the required limits, the nominal CRQLs will be applied.

CAS - Chemical Abstracts Service

AES - atomic emission spectroscopy

EPA - Environmental Protection Agency

CLP - contract laboratory program

CRQL - contract required quantitation limit

MA - modified analysis

N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection

NJMCL - New Jersey maximum concentration level

NL - not listed

PAL - project action limit

PQLG - project quantitation limit goal

MS - mass spectrometry

µg/L - microgram / Liter

QAPP WORKSHEET # 15f
Aqueous Screening Criteria - Inorganics - Surface water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic) [a]	National Recommended Water Quality Criteria (Chronic) [b]	EPA Region 3 (EPA3ECO) [c]	NJDEP Surface Water Quality Criteria for Fresh Water [d]	National Recommended Water Quality Criteria [e]	Surface Water PAL (µg/L)	Surface Water PQLG (µg/L)	CRQL - ISM02.4 ICP- MS (µg/L)
Metals - ISM02.4									
Aluminum	7429-90-5	NL	87	87	NL	NL	87	29	20
Antimony	7440-36-0	80	NL	30	5.6	5.6	5.6	2	2
Arsenic	7440-38-2	150	150	5	0.017	0.018	0.017	0.017	1
Barium	7440-39-3	220	NL	4	2,000	1,000	4	4	10
Beryllium	7440-41-7	3.6	NL	0.66	6	NL	0.66	0.66	1
Cadmium	7440-43-9	0.1	0.13	0.13	3.4	NL	0.1	0.1	1
Calcium	7440-70-2	NL	NL	116,000	NL	NL	116,000	38,667	500
Chromium	18540-29-9	10	11	11	NL	NL	10	3	2
Cobalt	7440-48-4	24	NL	23	NL	NL	24	8	1
Copper	7440-50-8	4	4.18	4.18	1,300	1,300	4	3	2
Cyanide	57-12-5	5.2	5.2	5	5.2	22	5	5	10
Iron	7439-89-6	NL	1000	300	NL	NL	300	300	500
Lead	7439-92-1	5.4	0.94	0.94	5	NL	0.94	3	1
Magnesium	7439-95-4	NL	NL	82,000	NL	NL	82,000	27,333	500
Manganese	7439-96-5	NL	NL	120	NL	50	50	17	1
Mercury	7439-97-6	0.77	0.77	0.026	0.05	NL	0.026	0.026	500
Nickel	7440-02-0	20.75	24.5	24.5	500	610	20.75	10	1
Potassium	7440-09-7	NL	NL	53,000	NL	NL	53,000	17,667	500
Selenium	7782-49-2	5	5	1	170	170	1	1	5
Silver	7440-22-4	0.12	0.69	0.69	170	NL	0.12	0.12	1
Sodium	7440-23-5	NL	NL	680,000	NL	NL	680,000	226,667	500
Thallium	7440-28-0	10	NL	0.8	0.24	0.24	0.24	0.24	1
Vanadium	7440-62-2	12	NL	20	NL	NL	12	7	5

QAPP WORKSHEET # 15f
Aqueous Screening Criteria - Inorganics - Surface water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic) [a]	National Recommended Water Quality Criteria (Chronic) [b]	EPA Region 3 (EPA3ECO) [c]	NJDEP Surface Water Quality Criteria for Fresh Water [d]	National Recommended Water Quality Criteria [e]	Surface Water PAL (µg/L)	Surface Water PQLG (µg/L)	CRQL - ISM02.4 ICP- MS (µg/L)
Zinc	7440-66-6	53.5	55.5	120	7,400	7,400	53.5	18	2

Notes:

1. Surface water PALs were selected as the minimum value presented in a through e below.

- (a) NJDEP Surface Water Quality Standards: Ecological Screening Criteria (Chronic), October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)
- (b) EPA National Recommended Aquatic Life Criteria table based on Freshwater CCC (chronic) values,
Accessed May 2017 (<http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm>)
- (c) EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks, July 2006
https://www.epa.gov/sites/production/files/2015-09/documents/r3_btag_fw_benchmarks_07-06.pdf
- (d) NJDEP Surface Water Quality Standards: Human Health Criteria, October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)
- (e) EPA National Recommended Water Quality Criteria, Human Health for the consumption of water and organism
Accessed May 2017 (<https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table>)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will request the existing CLP MAs for mercury (highlighted), as it is considered the primary compound of concern.

If no MAs exist to meet the required limits, the nominal CRQLs will be applied.

CAS - Chemical Abstracts Service
 AES - atomic emission spectroscopy
 EPA - Environmental Protection Agency
 CLP - contract laboratory program
 CRQL - contract required quantitation limit
 MA - modified analysis
 N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection
 NJMCL - New Jersey maximum concentration level
 NL - not listed
 PAL - project action limit
 PQLG - project quantitation limit goal
 MS - mass spectrometry
 µg/L - microgram / Liter

QAPP WORKSHEET # 15g
Aqueous Screening Criteria - Pesticides/PCBs - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health based Ground Water Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater PAL (µg/L)	Groundwater PQLG (µg/L)	CRQL - SOM02.4 Water (µg/L)
Pesticides								
alpha-BHC	319-84-6	NL	NL	0.006	0.0072	0.006	0.006	0.05
beta-BHC	319-85-7	NL	NL	0.02	0.025	0.02	0.02	0.05
delta-BHC	319-86-8	NL	NL	NL	NL	N/A	0.05	0.05
gamma-BHC (Lindane)	58-89-9	0.2	0.2	0.03	0.042	0.03	0.03	0.05
Heptachlor	76-44-8	0.4	0.4	0.008	0.0014	0.0014	0.0014	0.05
Aldrin	309-00-2	NL	NL	0.002	0.00092	0.00092	0.00092	0.05
Heptachlor epoxide	1024-57-3	0.2	0.2	0.004	0.0014	0.0014	0.0014	0.05
Endosulfan I	959-98-8	NL	NL	40	NL	40	13.3	0.05
Dieldrin	60-57-1	NL	NL	0.002	0.0018	0.0018	0.0018	0.10
4,4'-DDE	72-55-9	NL	NL	0.1	0.046	0.046	0.046	0.10
Endrin	72-20-8	2	2	2	2.3	2	0.67	0.10
Endosulfan II	33213-65-9	NL	NL	40	NL	40	13.3	0.10
4,4'-DDD	72-54-8	NL	NL	0.1	0.032	0.032	0.032	0.10
Endosulfan sulfate	1031-07-8	NL	NL	40	NL	40	13.3	0.10
4,4'-DDT	50-29-3	NL	NL	0.1	0.23	0.1	0.1	0.10
Methoxychlor	72-43-5	40	40	40	37	37	12.3	0.50
Endrin ketone	53494-7-5	NL	NL	NL	NL	N/A	0.1	0.10
Endrin aldehyde	7421-93-4	NL	NL	NL	NL	N/A	0.1	0.10
cis-Chlordane	5103-71-9	0.5	2	0.01	NL	0.01	0.01	0.05
trans-Chlordane	5103-74-2	0.5	2	0.01	NL	0.01	0.01	0.05
Toxaphene	8001-35-2	3	3	0.03	0.071	0.03	0.03	5.00
Polychlorinated Biphenyls								
Aroclor-1016	12674-11-2	0.5	0.5	0.02	0.22	0.02	0.02	1.0
Aroclor-1221	11104-28-2	0.5	0.5	0.02	0.0047	0.0047	0.0047	1.0
Aroclor-1232	11141-16-5	0.5	0.5	0.02	0.0047	0.0047	0.0047	1.0
Aroclor-1242	53469-21-9	0.5	0.5	0.02	0.0078	0.0078	0.0078	1.0
Aroclor-1248	12672-29-6	0.5	0.5	0.02	0.0078	0.0078	0.0078	1.0
Aroclor-1254	11097-69-1	0.5	0.5	0.02	0.0078	0.0078	0.0078	1.0
Aroclor-1260	11096-82-5	0.5	0.5	0.02	0.0078	0.0078	0.0078	1.0
Aroclor-1262	37324-23-5	0.5	0.5	0.02	NL	0.02	0.02	1.0
Aroclor-1268	11100-14-4	0.5	0.5	0.02	NL	0.02	0.02	1.0

QAPP WORKSHEET # 15g
Aqueous Screening Criteria - Pesticides/PCBs - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Notes:

1. PALs were selected as the minimum value presented in a through d below.

- (a) New Jersey Drinking Water Standards, February 10, 2009 (<http://www.nj.gov/dep/standards/drinking%20water.pdf>), downloaded May 13, 2017.
- (b) EPA National Primary Drinking Water Standards, EPA 816-F-09-0004, May 2009. (https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf)
- (c) New Jersey Ground Water Quality Standards Class IIA (N.J.A.C. 7:9C), March 2014. (http://www.nj.gov/dep/rules/rules/njac7_9c.pdf)
- (d) EPA Human health-based screening – RSL Tapwater (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus noncancer (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MAs for pesticides or PCBs, as they are not considered primary compounds of concern.

CAS - Chemical Abstracts Service

EPA - Environmental Protection Agency

CLP - contract laboratory program

CRQL - contract required quantitation limit

MA - modified analysis

N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection

NL - not listed

NJMCL - New Jersey maximum concentration level

PAL - project action limit

PQLG - project quantitation limit goal

RSL - regional screening level

µg/L - microgram per liter

QAPP WORKSHEET # 15h
Aqueous Screening Criteria - Pesticides/PCBs - Surface Water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic) [a]	National Recommended Water Quality Criteria [b] (Chronic)	EPA Region 3 (EPA3ECO) [c]	NJDEP Surface Water Quality Criteria for Fresh Water [d]	National Recommended Water Quality Criteria [e]	Surface Water PAL (µg/L)	Surface Water PQLG (µg/L)	CRQL - SOM02.4 Water (µg/L)
Pesticides									
alpha-BHC	319-84-6	12	NL	NL	0.0026	0.0026	0.0026	0.0026	0.05
beta-BHC	319-85-7	0.495	NL	NL	0.0091	0.0091	0.0091	0.0091	0.05
delta-BHC	319-86-8	NL	NL	141	NL	NL	141	47	0.05
gamma-BHC (Lindane)	58-89-9	0.026	0.950	0.010	1	1	0.01	0.01	0.05
Heptachlor	76-44-8	0.004	0.004	0.002	0.000079	0.000079	0.000079	0.000079	0.05
Aldrin	309-00-2	0.017	3	3	0.000049	0.000049	0.000049	0.000049	0.05
Heptachlor epoxide	1024-57-3	0.0038	0.0038	0.0019	0.000039	0.000039	0.000039	0.000039	0.05
Endosulfan I	959-98-8	0.056	0.056	0.0510	62	62	0.051	0.050	0.05
Dieldrin	60-57-1	0.056	0.056	0.0560	0.000052	0.000052	0.000052	0.000052	0.10
4,4'-DDE	72-55-9	0.00022	0.001	NL	0.00022	0.00022	0.00022	0.00022	0.10
Endrin	72-20-8	0.036	0.036	0.036	0.059	0.059	0.036	0.036	0.10
Endosulfan II	33213-65-9	0.056	0.056	0.051	62	62	0.051	0.051	0.10
4,4'-DDD	72-54-8	NL	0.001	0.011	0.00031	0.00031	0.00031	0.00031	0.10
Endosulfan sulfate	1031-07-8	2	NL	NL	62	62	2.22	0.74	0.10
4,4'-DDT	50-29-3	0.001	0.001	0.0005	0.00022	0.00022	0.00022	0.00022	0.10
Methoxychlor	72-43-5	0.03	0.03	0.019	40	100	0.019	0.019	0.50
Endrin ketone	53494-7-5	NL	NL	NL	NL	NL	N/A	N/A	0.10
Endrin aldehyde	7421-93-4	0.1500	NL	NL	0.0590	0.2900	0.059	0.059	0.10
cis-Chlordane	5103-71-9	0.0043	0.0043	0.0022	0.0001	0.0008	0.0001	0.0001	0.05
trans-Chlordane	5103-74-2	0.0043	0.0043	0.0022	NL	0.0008	0.0008	0.0008	0.05
Toxaphene	8001-35-2	0.0002	0.0002	0.0002	0.00028	0.00028	0.0002	0.0002	5.00
Polychlorinated Biphenyls									
Aroclor-1016	12674-11-2	0.014	0.014	0.00007	0.000064	0.000064	0.000064	0.000064	1.0
Aroclor-1221	11104-28-2	0.014	0.014	0.00007	0.000064	0.000064	0.000064	0.000064	1.0
Aroclor-1232	11141-16-5	0.014	0.014	0.00007	0.000064	0.000064	0.000064	0.000064	1.0
Aroclor-1242	53469-21-9	0.014	0.014	0.00007	0.000064	0.000064	0.000064	0.000064	1.0
Aroclor-1248	12672-29-6	0.014	0.014	0.00007	0.000064	0.000064	0.000064	0.000064	1.0
Aroclor-1254	11097-69-1	0.014	0.014	0.00007	0.000064	0.000064	0.000064	0.000064	1.0
Aroclor-1260	11096-82-5	0.014	0.014	0.00007	0.000064	0.000064	0.000064	0.000064	1.0
Aroclor-1262	37324-23-5	0.014	0.014	0.00007	0.000064	0.000064	0.000064	0.000064	1.0
Aroclor-1268	11100-14-4	0.014	0.014	0.00007	0.000064	0.000064	0.000064	0.000064	1.0

QAPP WORKSHEET # 15h
Aqueous Screening Criteria - Pesticides/PCBs - Surface Water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Notes:

1. Surface water PALs were selected as the minimum value presented in a through e below.
 - (a) NJDEP Surface Water Quality Standards: Ecological Screening Criteria (Chronic), October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)
 - (b) EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks, July 2006
https://www.epa.gov/sites/production/files/2015-09/documents/r3_btag_fw_benchmarks_07-06.pdf
 - (c) EPA National Recommended Aquatic Life Criteria table based on Freshwater CCC (chronic) values,
Accessed May 2017 (<http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm>)
 - (d) NJDEP Surface Water Quality Standards: Human Health Criteria, October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)
 - (e) EPA National Recommended Water Quality Criteria, Human Health for the consumption of water and organism
Accessed May 2017 (<https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table>)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MAs for pesticides or PCBs, as they are not considered primary compounds of concern.

CAS - Chemical Abstracts Service

EPA - Environmental Protection Agency

CLP - contract laboratory program

CRQL - contract required quantitation limit

MA - modified analysis

N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection

NL - not listed

NJ GWQC - New Jersey Groundwater Quality Criteria

PAL - project action limit

PQLG - project quantitation limit goal

RSL - regional screening level

µg/L - microgram per liter

QAPP WORKSHEET # 15i
Aqueous Screening Criteria - Wet Chemistry - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: mg/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health based Groundwater Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater PAL (mg/L)	Groundwater PQLG (mg/L)	RL - Water (mg/L)
Alkalinity	N/A	N/A	N/A	N/A	N/A	N/A	1	1
Ammonia	7664-41-7	3	N/A	3	N/A	3	3	0.05
Bicarbonate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chloride	16887-00-6	250	N/A	250	N/A	250	250	1
DOC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nitrate	14797-55-8	10	10	10	10	10	10	0.1
Phosphate	98059-61-1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
POC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sulfate	18785-72-3	250	N/A	250	N/A	250	250	0.05
TDS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TSS	N/A	N/A	N/A	N/A	N/A	N/A	10	10
Methylmercury - EPA 1630								
Analyte (All Units: ng/L)	CAS Number	New Jersey Drinking Water Standards (NJMCL) [a]	EPA National Primary Drinking Water Standards [b]	NJDEP Health based Groundwater Quality Criteria [c]	EPA RSL for Tapwater [d]	Groundwater PAL (ng/L)	Groundwater PQLG (ng/L)	RL - Water (ng/L)
Methylmercury	22967-92-6	N/A	N/A	N/A	N/A	N/A	0.05	0.05

QAPP WORKSHEET # 15i
Aqueous Screening Criteria - Wet Chemistry - Groundwater
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Notes:

1. PALs were selected as the minimum value presented in a through d above.

(a) New Jersey Drinking Water Standards, February 10, 2009 (<http://www.nj.gov/dep/standards/drinking%20water.pdf>), downloaded May 13, 2017.

(b) EPA National Primary Drinking Water Standards, EPA 816-F-09-0004, May 2009. (https://www.epa.gov/sites/production/files/2016-06/documents/npwdr_complete_table.pdf)

(c) New Jersey Ground Water Quality Standards Class IIA (N.J.A.C. 7:9C), March 2014. (http://www.nj.gov/dep/rules/rules/njac7_9c.pdf)

(d) EPA Human health-based screening – RSL Tapwater (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus noncancer endpoints was selected.

(http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

CAS - Chemical Abstracts Service

EPA - Environmental Protection Agency

CLP - contract laboratory program

CRQL - contract required quantitation limit

MA - modified analysis

N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection

NL - not listed

ng/L - nanogram per liter

NJMCL - New Jersey maximum concentration level

mg/L milligram/Liter

PAL - project action limit

PQLG - project quantitation limit goal

DOC - dissolved organic carbon

TDS - total dissolved solids

POC - particulate organic carbon

TSS - total suspended solids

QAPP WORKSHEET # 15j
Aqueous Screening Criteria - Wet Chemistry - Surface Water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: mg/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic) [a]	National Recommended Water Quality Criteria (Chronic) [b]	EPA Region 3 (EPA3ECO) [c]	NJDEP Surface Water Quality Criteria for Fresh Water [d]	National Recommended Water Quality Criteria [e]	Surface Water PAL (mg/L)	Surface Water PQLG (mg/L)	RL - Water (mg/L)
Alkalinity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	1
Ammonia	7664-41-7	N/A	N/A	N/A	N/A	N/A	N/A	0.05	0.05
Bicarbonate	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chloride	16887-00-6	230	N/A	230	N/A	N/A	230	230	1
DOC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nitrate	14797-55-8	N/A	N/A	N/A	N/A	N/A	10	10	0.1
Phosphate	98059-61-1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
POC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Sulfate	18785-72-3	N/A	N/A	N/A	N/A	N/A	N/A	0.05	0.05
TDS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TSS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	10	10
Methylmercury - EPA 1630									
Analyte (All Units: ng/L)	CAS Number	NJDEP Ecological Screening Criteria (Chronic)	National Recommended Water Quality Criteria (Chronic)	EPA Region 3 (EPA3ECO)	NJDEP Surface Water Quality Criteria for Fresh Water	National Recommended Water Quality Criteria	Surface Water PAL (ng/L)	Surface Water PQLG (ng/L)	RL - Water (ng/L)
Methylmercury	22967-92-6	N/A	N/A	N/A	N/A	N/A	N/A	0.05	0.05

QAPP WORKSHEET # 15j
Aqueous Screening Criteria - Wet Chemistry - Surface Water
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Notes:

1. Surface water PALs were selected as the minimum value presented in a through e below.
 - (a) NJDEP Surface Water Quality Standards: Ecological Screening Criteria (Chronic), October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)
 - (b) EPA National Recommended Aquatic Life Criteria table based on Freshwater CCC (chronic) values,
Accessed May 2017 (<http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm>)
 - (c) EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks, July 2006
https://www.epa.gov/sites/production/files/2015-09/documents/r3_btag_fw_benchmarks_07-06.pdf
 - (d) NJDEP Surface Water Quality Standards: Human Health Criteria, October 2016
(http://www.nj.gov/dep/rules/rules/njac7_9b.pdf)
 - (e) EPA National Recommended Water Quality Criteria, Human Health for the consumption of water and organism
Accessed May 2017 (<https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table>)

CAS - Chemical Abstracts Service

EPA - Environmental Protection Agency

CLP - contract laboratory program

CRQL - contract required quantitation limit

MA - modified analysis

N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection

NL - not listed

NJMCL - New Jersey maximum concentration level

mg/L milligram/Liter

PAL - project action limit

PQLG - project quantitation limit goal

DOC - dissolved organic carbon

TDS - total dissolved solids

POC - particulate organic carbon

TSS - total suspended solids

QAPP WORKSHEET # 15k
Soil Screening Criteria and PALs - VOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (µg/kg)	Soil PQLG (µg/kg)	CRQL - SOM02.4 Low Soil	CRQL - SOM02.4 Medium Soil
		NJDEP Residential Direct Contact Rem. Stand. [a]	EPA RSL for Residential Soil [b]	EPA EcoSSLs [c]	NJDEP Wildlife PRGs [d]	PRGs for Ecological Endpoints [e]	EPA Region 5 [f]				
1,1,1-Trichloroethane	71-55-6	290,000	8,100,000	NL	29,800	NL	29,800	29,800	9933	5.0	250
1,1,2,2-Tetrachloroethane	79-34-5	1,000	600	NL	127	NL	127	127	42	5.0	250
1,1,2-Trichloro-1,2,2-	76-13-1	NL	6,700,000	NL	NL	NL	NL	6,700,000	2,233,333	5.0	250
1,1,2-Trichloroethane	79-00-5	2,000	1,100	NL	28,600	NL	28,600	1,100	367	5.0	250
1,1-Dichloroethane	75-34-3	8,000	3,600	NL	NL	NL	20,100	3,600	1,200	5.0	250
1,1-Dichloroethene	75-35-4	11,000	230,000	NL	8,280	NL	8,280	8,280	2,760	5.0	250
1,2,3-Trichlorobenzene	87-61-6	NL	63,000	NL	20,000	20,000	NL	20,000	6,667	5.0	250
1,2,4-Trichlorobenzene	120-82-1	73,000	24,000	NL	20,000	20,000	11,100	11,100	3,700	5.0	250
1,2-Dibromo-3-chloropropane	96-12-8	80	5.3	NL	NL	NL	35.2	5.3	5	5.0	250
1,2-Dibromoethane	106-93-4	8	36	NL	NL	NL	1,230	8	6	5.0	250
1,2-Dichlorobenzene	95-50-1	5,300,000	1,800,000	NL	2,960	NL	2,960	2,960	987	5.0	250
1,2-Dichloroethane	107-06-2	900	460	NL	21,200	NL	21,200	460	153	5.0	250
1,2-Dichloropropane	78-87-5	2,000	280	NL	32,700	NL	32,700	280	93	5.0	250
1,3-Dichlorobenzene	541-73-1	5,300,000	NL	NL	37,700	NL	37,700	37,700	12,567	5.0	250
1,4-Dichlorobenzene	106-46-7	5,000	2,600	NL	20,000	20,000	546	546	182	5.0	250
2-Butanone	78-93-3	3,100,000	27,000,000	NL	NL	NL	89,600	89,600	29,867	10.0	500
2-Hexanone	591-78-6	NL	200,000	NL	NL	NL	12,600	12,600	4,200	10.0	500
4-Methyl-2-pentanone	108-10-1	NL	33,000,000	NL	NL	NL	443,000	443,000	147,667	10.0	500
Acetone	67-64-1	70,000,000	61,000,000	NL	NL	NL	2,500	2,500	833	10.0	500
Benzene	71-43-2	2,000	1,200	NL	255	NL	255	255	85	5.0	250
Bromochloromethane	74-97-5	NL	150,000	NL	NL	NL	NL	150,000	50,000	5.0	250
Bromodichloromethane	75-27-4	1,000	290	NL	540	NL	540	290	97	5.0	250
Bromoform	75-25-2	81,000	19,000	NL	15,900	NL	15,900	15,900	5,300	5.0	250
Bromomethane	74-83-9	25,000	6,800	NL	235	NL	235	235	78	5.0	250
Carbon Disulfide	75-15-0	7,800,000	770,000	NL	NL	NL	94.1	94.1	31	5.0	250
Carbon Tetrachloride	56-23-5	600	650	NL	2,980	NL	2,980	600	200	5.0	250
Chlorobenzene	108-90-7	510,000	280,000	NL	40,000	40,000	13,100	13,100	4,367	5.0	250
Chloroethane	75-00-3	220,000	14,000,000	NL	NL	NL	NL	220,000	73,333	5.0	250
Chloroform	67-66-3	600	320	NL	1,190	NL	1,190	320	107	5.0	250
Chloromethane	74-87-3	4,000	110,000	NL	NL	NL	10,400	4,000	1,333	5.0	250
cis-1,2-Dichloroethene	156-59-2	230,000	160,000	NL	NL	NL	NL	160,000	53,333	5.0	250
cis-1,3-Dichloropropene	542-75-6	2,000	1,800	NL	NL	NL	398	398	133	5.0	250
Cyclohexane	110-82-7	NL	6,500,000	NL	NL	NL	NL	6,500,000	2,166,667	5.0	250
Dibromochloromethane	124-48-1	3,000	8,300	NL	2,050	NL	2,050	2,050	683	5.0	250
Dichlorodifluoromethane	75-71-8	490,000	87,000	NL	NL	NL	39,500	39,500	13,167	5.0	250

QAPP WORKSHEET # 15k
Soil Screening Criteria and PALs - VOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (µg/kg)	Soil PQLG (µg/kg)	CRQL - SOM02.4 Low Soil	CRQL - SOM02.4 Medium Soil
		NJDEP Residential Direct Contact Rem. Stand. [a]	EPA RSL for Residential Soil [b]	EPA EcoSSLs [c]	NJDEP Wildlife PRGs [d]	PRGs for Ecological Endpoints [e]	EPA Region 5 [f]				
Ethylbenzene	100-41-4	7,800,000	5,800	NL	5,160	NL	5,160	5,160	1,720	5.0	250
Isopropylbenzene	98-82-8	NL	1,900,000	NL	NL	NL	NL	1,900,000	633,333	5.0	250
m,p-Xylene*	108-38-3	12,000,000	550,000	NL	10000	NL	10000	10,000	3,333	5.0	250
Methyl Acetate	79-20-9	78,000,000	78,000,000	NL	NL	NL	NL	78,000,000	26,000,000	5.0	250
Methyl tert-Butyl Ether	1634-04-4	110,000	47,000	NL	NL	NL	NL	47,000	15,667	5.0	250
Methylcyclohexane	108-87-2	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0	250
Methylene Chloride	75-09-2	34,000	57,000	NL	4,050	NL	4,050	4,050	1,350	5.0	250
o-Xylene**	95-47-6	12,000,000	650,000	NL	10,000	NL	10,000	10,000	3,333	5.0	250
Styrene	100-42-5	90,000	6,000,000	NL	300,000	300,000	4,690	4,690	1,563	5.0	250
Tetrachloroethene	127-18-4	2,000	24,000	NL	9,920	NL	9,920	2,000	667	5.0	250
Toluene	108-88-3	6,300,000	4,900,000	NL	200,000	200,000	5,450	5,450	1,817	5.0	250
trans-1,2-Dichloroethene	156-60-5	300,000	1,600,000	NL	784	NL	784	784	261	5.0	250
trans-1,3-Dichloropropene	542-75-6	2,000	1,800	NL	NL	NL	398	398	133	5.0	250
Trichloroethene	79-01-6	7,000	940	NL	12,400	NL	12,400	940	313	5.0	250
Trichlorofluoromethane	75-69-4	23,000,000	23,000,000	NL	NL	NL	16,400	16,400	5,467	5.0	250
Vinyl Chloride	75-01-4	700	59	NL	646	NL	646	59	20	5.0	250
Xylenes (Total)	1330-20-7	12,000,000	580,000	NL	10,000	NL	10,000	10,000	N/A	N/A	N/A

Notes:

1. Soil PALs were selected as the minimum value presented in a through f below.

(a) NJDEP Risk-based and remediation standard criteria for Residential Direct Contact Soil Remediation Standard, Last Amended May 2012 (<http://www.nj.gov/dep/srp/regs/rs/>)

(b) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus

(c) EPA Ecological Soil Screening Levels (EcoSSLs). <http://www.epa.gov/ecotox/ecoss/>

(d) NJDEP Ecological Screening Criteria for the wildlife PRGs for soil, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

When two values were presented in the table, the value based on a study was used.

(e) Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals (PRGs) for Ecological Endpoints.

Prepared for the U.S. Department of Energy, Office of Environmental Management Contract No. DE-AC05-84OR21401.

(f) EPA 2003. EPA Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels.

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MA for VOCs as they are not considered a primary compound of interest.

*Xylene (total) was used for m,p-xylene PAL criteria. M-xylene and p-xylene are reported as one compound under SOM02.4.

** Xylene (total) was used for o-xylene PAL criteria.

CAS - Chemical Abstracts Service

CRQL - contract required quantitation limit

EPA - Environmental Protection Agency

MA - modified analysis

µg/kg - microgram per kilogram

N/A - not applicable

NL - not listed

NJDEP - New Jersey Department of Environmental Protection

PAL - project action limit

PQLG - project quantitation limit goal

QAPP WORKSHEET # 151
Sediment Screening Criteria and PALs - VOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (µg/kg)	Sediment PQLG (µg/kg)	CRQL - SOM02.4 Low Soil	CRQL - SOM02.4 Medium Soil
		NJDEP Fresh Water	EPA Region 3 Freshwater	EPA RSL for Residential Soil				
1,1,1-Trichloroethane	71-55-6	213	30.2	8,100,000	30.2	10	5.0	250
1,1,2,2-Tetrachloroethane	79-34-5	850	1360	600	600	200	5.0	250
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	NL	NL	6,700,000	6,700,000	2,233,333	5.0	250
1,1,2-Trichloroethane	79-00-5	518	1240	1,100	518	173	5.0	250
1,1-Dichloroethane	75-34-3	NL	NL	3,600	3,600	1,200	5.0	250
1,1-Dichloroethene	75-35-4	19.4	31	230,000	19.4	6	5.0	250
1,2,3-Trichlorobenzene	87-61-6	NL	858	63,000	858	286	5.0	250
1,2,4-Trichlorobenzene	120-82-1	5,062	2,100	24,000	2,100	700	5.0	250
1,2-Dibromo-3-chloropropane	96-12-8	NL	NL	5.3	5.3	5	5.0	250
1,2-Dibromoethane	106-93-4	NL	NL	36	36	12	5.0	250
1,2-Dichlorobenzene	95-50-1	294	16.5	1,800,000	16.5	6	5.0	250
1,2-Dichloroethane	107-06-2	260	NL	460	260	87	5.0	250
1,2-Dichloropropane	78-87-5	333	NL	280	280	93	5.0	250
1,3-Dichlorobenzene	541-73-1	1,315	4,430	NL	1,315	438	5.0	250
1,4-Dichlorobenzene	106-46-7	318	599	2,600	318	106	5.0	250
2-Butanone	78-93-3	NL	NL	27,000,000	27,000,000	9,000,000	10.0	500
2-Hexanone	591-78-6	NL	NL	200,000	200,000	66,667	10.0	500
4-Methyl-2-pentanone	108-10-1	NL	NL	33,000,000	33,000,000	11,000,000	10.0	500
Acetone	67-64-1	NL	NL	61,000,000	61,000,000	20,333,333	10.0	500
Benzene	71-43-2	340	NL	1,200	340	113	5.0	250
Bromochloromethane	74-97-5	NL	NL	150,000	150,000	50,000	5.0	250
Bromodichloromethane	75-27-4	NL	NL	290	290	97	5.0	250
Bromoform	75-25-2	492	654	19,000	492	164	5.0	250
Bromomethane	74-83-9	1.37	NL	6,800	1.37	1.4	5.0	250
Carbon Disulfide	75-15-0	NL	0.851	770,000	0.851	0.9	5.0	250

QAPP WORKSHEET # 151
Sediment Screening Criteria and PALs - VOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (µg/kg)	Sediment PQLG (µg/kg)	CRQL - SOM02.4 Low Soil	CRQL - SOM02.4 Medium Soil
		NJDEP Fresh Water	EPA Region 3 Freshwater	EPA RSL for Residential Soil				
Carbon Tetrachloride	56-23-5	1,450	64.2	650	64.2	21	5.0	250
Chlorobenzene	108-90-7	291	8.42	280,000	8.42	5	5.0	250
Chloroethane	75-00-3	NL	NL	14,000,000	14,000,000	4,666,667	5.0	250
Chloroform	67-66-3	121	NL	320	121	40	5.0	250
Chloromethane	74-87-3	NL	NL	110,000	110,000	36,667	5.0	250
cis-1,2-Dichloroethene	156-59-2	NL	NL	160,000	160,000	53,333	5.0	250
cis-1,3-Dichloropropene	542-75-6	NL	NL	1,800	1,800	600	5.0	250
Cyclohexane	110-82-7	NL	NL	6,500,000	6,500,000	2,166,667	5.0	250
Dibromochloromethane	124-48-1	NL	NL	8,300	8,300	2,767	5.0	250
Dichlorodifluoromethane	75-71-8	NL	NL	87,000	87,000	29,000	5.0	250
Ethylbenzene	100-41-4	1,400	1,100	5,800	1,100	367	5.0	250
Isopropylbenzene	98-82-8	NL	86	1,900,000	86	29	5.0	250
m,p-Xylene*	108-38-3	120	NL	550,000	120	40	5.0	250
Methyl Acetate	79-20-9	NL	NL	78,000,000	78,000,000	26,000,000	5.0	250
Methyl tert-Butyl Ether	1634-04-4	NL	NL	47,000	47,000	15,667	5.0	250
Methylcyclohexane	108-87-2	NL	NL	NL	N/A	N/A	5.0	250
Methylene Chloride	75-09-2	159	NL	57,000	159	53	5.0	250
o-Xylene**	95-47-6	120	NL	650,000	120	40	5.0	250
Styrene	100-42-5	254	559	6,000,000	254	85	5.0	250
Tetrachloroethene	127-18-4	450	468	24,000	450	150	5.0	250
Toluene	108-88-3	2,500	NL	4,900,000	2,500	833	5.0	250
trans-1,2-Dichloroethene	156-60-5	654	1,050	1,600,000	654	218	5.0	250
trans-1,3-Dichloropropene	542-75-6	NL	NL	1,800	1,800	600	5.0	250
Trichloroethene	79-01-6	1,600	96.9	940	96.9	32	5.0	250
Trichlorofluoromethane	75-69-4	NL	NL	23,000,000	23,000,000	7,666,667	5.0	250

QAPP WORKSHEET # 15I
Sediment Screening Criteria and PALs - VOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (µg/kg)	Sediment PQLG (µg/kg)	CRQL - SOM02.4 Low Soil	CRQL - SOM02.4 Medium Soil
		NJDEP Fresh Water	EPA Region 3 Freshwater	EPA RSL for Residential Soil				
Vinyl Chloride	75-01-4	202	NL	59	59	20	5.0	250
Xylenes (Total)	1330-20-7	120	NL	580,000	120	120	N/A	N/A

Notes:

1. Sediment PALs were selected as the minimum value presented in a through c below.

(a) NJDEP Ecological Screening Criteria for the lowest effects level for fresh water criteria, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

(b) EPA Region 3 Freshwater Sediment Screening Benchmarks, August 2006 (<https://www.epa.gov/risk/freshwater-sediment-screening-benchmarks>)

(c) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), May 2016
(http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MA for VOCs as they are not considered a primary compound of interest.

*Xylene (total) was used for m,p-xylene PAL criteria. M-xylene and p-xylene are reported as one compound under SOM02.4.

** Xylene (total) was used for o-xylene PAL criteria.

CRQL - contract required quantitation limit

EPA - Environmental Protection Agency

MA - modified analysis

N/A - not applicable

NL - not listed

NJDEP - New Jersey Department of Environmental Protection

PAL - project action limit

PQLG - project quantitation limit goal

µg/kg - microgram per kilogram

CAS - Chemical Abstracts Service

QAPP WORKSHEET # 15m
Soil Screening Criteria and PALS - SVOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (µg/kg)	Soil PQLG (µg/kg)	CRQL - SOM02.4 Low Soil (µg/kg)	CRQL - SOM0.24 Medium Soil (µg/kg)
		NJDEP Residential Direct Contact Remediation Standard [a]	EPA RSL for Residential Soil [b]	EPA EcoSSLs [c]	NJDEP Wildlife PRGs [d]	PRGs for Ecological Endpoints [e]	EPA Region 5 [f]				
1,1'-Biphenyl	92-52-4	3,100,000	47,000	NL	60,000	60,000	NL	47,000	15,667	170	5,000
1,4-Dioxane	123-91-1	NL	5,300	NL	NL	NL	2,050	2,050	683	67	2,000
1,2,4,5-Tetrachlorobenzene	95-94-3	NL	23,000	NL	2,020	NL	2,020	2,020	673	170	5,000
2,2'-oxybis(1-Chloropropane)	108-60-1	23,000	3,100,000	NL	19,900	NL	19,900	19,900	6,633	330	10,000
2,3,4,6-Tetrachlorophenol	58-90-2	NL	1,900,000	NL	NL	NL	199	199	170	170	5,000
2,4,5-Trichlorophenol	95-95-4	6,100,000	6,300,000	NL	9,000	9,000	14,100	9,000	3,000	170	5,000
2,4,6-Trichlorophenol	88-06-2	19,000	49,000	NL	4,000	4,000	9,940	4,000	1,333	170	5,000
2,4-Dichlorophenol	120-83-2	180,000	190,000	NL	87,500	NL	87,500	87,500	29,167	170	5,000
2,4-Dimethylphenol	105-67-9	1,200,000	1,300,000	NL	10	NL	10	10	10	170	5,000
2,4-Dinitrophenol	51-28-5	120,000	130,000	NL	20,000	20,000	60.9	60.9	60.9	330	10,000
2,4-Dinitrotoluene	121-14-2	700	1,700	NL	1,280	NL	1,280	700	233	170	5,000
2,6-Dinitrotoluene	606-20-2	700	360	NL	NL	NL	32.8	32.8	32.8	170	5,000
2-Chloronaphthalene	91-58-7	NL	4,800,000	NL	12.2	NL	12.2	12.2	12	170	5,000
2-Chlorophenol	95-57-8	310,000	390,000	NL	243	NL	243	243	170	170	5,000
2-Methylnaphthalene	91-57-6	230,000	240,000	NL	3,240	NL	3,240	3,240	1,080	170	5,000
2-Methylphenol	95-48-7	310,000	3,200,000	NL	NL	NL	40,400	40,400	13,467	330	10,000
2-Nitroaniline	88-74-4	39,000	630,000	NL	NL	NL	74,100	39,000	13,000	170	5,000
2-Nitrophenol	88-75-5	NL	NL	NL	NL	NL	1,600	1,600	533	170	5,000
3,3'-Dichlorobenzidine	91-94-1	1,000	1,200	NL	646	NL	646	646	330	330	10,000
3-Methylphenol*	108-39-4	NL	3,200,000	NL	NL	NL	NL	3,200,000	3,200,000	NL	NL
3-Nitroaniline	99-09-2	NL	NL	NL	NL	NL	3,160	3,160	1,053	330	10,000
4,6-Dinitro-2-methylphenol	534-52-1	6,000	5,100	NL	NL	NL	144	144	144	330	10,000
4-Bromophenyl-phenylether	101-55-3	NL	NL	NL	NL	NL	NL	N/A	170	170	5,000
4-Chloro-3-methylphenol	59-50-7	NL	6,300,000	NL	NL	NL	7,950	7,950	2,650	170	5,000
4-Chloroaniline	106-47-8	NL	2,700	NL	NL	NL	1,100	1,100	367	330	10,000
4-Chlorophenyl-phenyl ether	7005-72-3	NL	NL	NL	NL	NL	NL	N/A	170	170	5,000
4-Methylphenol**	106-44-5	31,000	6,300,000	NL	NL	NL	163,000	31,000	10,333	330	10,000
4-Nitroaniline	100-01-6	NL	27,000	NL	NL	NL	21,900	21,900	7,300	330	10,000
4-Nitrophenol	100-02-7	NL	NL	NL	NL	7,000	5,120	5,120	1,707	330	10,000
Acenaphthene	83-32-9	3,400,000	3,600,000	29,000	20,000	20,000	682,000	20,000	6,667	170	5,000
Acenaphthylene	208-96-8	NL	NL	29,000	682,000	NL	682,000	29,000	9,667	170	5,000
Acetophenone	98-86-2	2,000	7,800,000	NL	NL	NL	300,000	2,000	667	330	10,000
Anthracene	120-12-7	17,000,000	18,000,000	29,000	1,480,000	NL	1,480,000	29,000	9,667	170	5,000
Atrazine	1912-24-9	210,000	2,400	NL	NL	NL	NL	2,400	800	330	10,000
Benzaldehyde	100-52-7	6,100,000	170,000	NL	NL	NL	NL	170,000	56,667	330	10,000
Benzo(a)anthracene	56-55-3	600	1,100	1,100	5,210	NL	5,210	600	200	170	5,000
Benzo(a)pyrene	50-32-8	200	110	1,100	1,520	NL	1,520	110	110	170	5,000
Benzo(b)fluoranthene	205-99-2	600	1,100	1,100	59,800	NL	59,800	600	200	170	5,000
Benzo(g,h,i)perylene	191-24-2	380,000,000	NL	1,100	119,000	NL	119,000	1,100	367	170	5,000
Benzo(k)fluoranthene	207-08-9	6,000	11,000	1,100	148,000	NL	148,000	1,100	367	170	5,000
bis(2-Chloroethoxy) methane	111-91-1	NL	190,000	NL	NL	NL	302	302	170	170	5,000
bis(2-Chloroethyl) ether	111-44-4	400	230	NL	23,700	NL	23,700	230	230	330	10,000
bis-(2-Ethylhexyl)phthalate	117-81-7	35,000	39,000	NL	925	NL	925	925	308	170	5,000
Butylbenzylphthalate	85-68-7	1,200,000	290,000	NL	239	NL	239	239	170	170	5,000
Caprolactam	105-60-2	31,000,000	31,000,000	NL	NL	NL	NL	31,000,000	10,333,333	330	10,000
Carbazole	86-74-8	24,000	NL	NL	NL	NL	NL	24,000	8,000	330	10,000
Chrysene	218-01-9	62,000	110,000	1,100	4,730	NL	4,730	1,100	367	170	5,000
Dibenzo(a,h)anthracene	53-70-3	200	110	1,100	18,400	NL	18,400	110	110	170	5,000
Dibenzofuran	132-64-9	NL	73,000	NL	NL	NL	NL	73,000	24,333	170	5,000
Diethylphthalate	84-66-2	49,000,000	51,000,000	NL	NL	100,000	24,800	24,800	8,267	170	5,000
Dimethylphthalate	131-11-3	NL	NL	NL	NL	NL	734,000	734,000	244,667	170	5,000
Di-n-butylphthalate	84-74-2	6,100,000	6,300,000	NL	NL	200,000	150	150	150	170	5,000
Di-n-octylphthalate	117-84-0	2,400,000	630,000	NL	NL	NL	709,000	630,000	210,000	330	10,000
Fluoranthene	206-44-0	2,300,000	2,400,000	1,100	122,000	NL	122,000	1,100	367	170	10,000

QAPP WORKSHEET # 15m
Soil Screening Criteria and PALS - SVOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (µg/kg)	Soil PQLG (µg/kg)	CRQL - SOM02.4 Low Soil (µg/kg)	CRQL - SOM0.24 Medium Soil (µg/kg)
		NJDEP Residential Direct Contact Remediation Standard [a]	EPA RSL for Residential Soil [b]	EPA EcoSSLs [c]	NJDEP Wildlife PRGs [d]	PRGs for Ecological Endpoints [e]	EPA Region 5 [f]				
Fluorene	86-73-7	2,300,000	2,400,000	29,000	122,000	NL	122,000	29,000	9,667	330	5,000
Hexachlorobenzene	118-74-1	300	210	NL	199	NL	199	199	170	170	5,000
Hexachlorobutadiene	87-68-3	6,000	1,200	NL	39.8	NL	39.8	40	40	170	5,000
Hexachlorocyclopentadiene	77-47-4	45,000	1,800	NL	NL	10,000	755	755	330	330	10,000
Hexachloroethane	67-72-1	35,000	1,800	NL	596	NL	596	596	199	170	5,000
Indeno(1,2,3-cd)pyrene	193-39-5	600	1,100	1,100	109,000	NL	109,000	600	200	170	5,000
Isophorone	78-59-1	510,000	570,000	NL	139,000	NL	139,000	139,000	46,333	170	5,000
Naphthalene	91-20-3	6,000	3,800	29,000	99.4	NL	99.4	99	99	170	5,000
Nitrobenzene	98-95-3	31,000	5,100	NL	1,310	NL	1,310	1,310	437	170	5,000
N-Nitroso-di-n-propylamine	86-30-6	99,000	110,000	NL	545	NL	544	544	181	170	5,000
N-Nitrosodiphenylamine	621-64-7	200	78	NL	NL	NL	545	78	78	170	5,000
Pentachlorophenol	87-86-5	3,000	1,000	2,100	NL	3,000	119	119	119	330	10,000
Phenanthrene	85-01-8	NL	NL	29,000	45,700	NL	45,700	29,000	9,667	170	5,000
Phenol	108-95-2	18,000,000	19,000,000	NL	NL	30,000	120,000	30,000	10,000	330	10,000
Pyrene	129-00-0	1,700,000	1,800,000	1,100	78,500	NL	78,500	1,100	367	170	5,000

Notes:

1. Soil PALs were selected as the minimum value presented in a through f below.

(a) NJDEP Risk-based and remediation standard criteria for Residential Direct Contact Soil Remediation Standard, Last Amended May 2012 (<http://www.nj.gov/dep/srp/regs/rs/>)

(b) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus

(c) EPA Ecological Soil Screening Levels (EcoSSLs). <http://www.epa.gov/ecotox/ecoss/>

(d) NJDEP Ecological Screening Criteria for the wildlife PRGs for soil, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

When two values were presented in the table, the value based on a study was used.

(e) Efromson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals (PRGs) for Ecological Endpoints.

Prepared for the U.S. Department of Energy, Office of Environmental Management Contract No. DE-AC05-84OR21401.

(f) EPA 2003. EPA Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels.

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MA for SVOCs as they are not considered a primary compound of interest.

****4-Methylphenol** result will include 3-methylphenol since the isomers cannot be separated by the SOM02.4 extraction method and GC column used.

***3-Methylphenol** will need to be added via an MA [based on method 8041A or equivalent] to obtain result since this compound is not on the TCL.

CLP - contract laboratory program

CRQL - contract required quantitation limit

EPA - Environmental Protection Agency

MA - modified analysis

N/A - not applicable

NL - not listed

NJDEP - New Jersey Department of Environmental Protection

PAL - project action limit

PQLG - project quantitation limit goal

PRG - preliminary remediation goals

RSL - regional screening level

SVOCs - semivolatile organic compounds

µg/kg - microgram per kilogram

CAS - Chemical Abstracts Service

QAPP WORKSHEET # 15n
Sediment Screening Criteria and PALs - SVOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (µg/kg)	Sediment PQLG (µg/kg)	CRQL - SOM02.4 Low Soil (µg/kg)	CRQL - SOM0.24 Medium Soil (µg/kg)
		NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil [c]				
1,1'-Biphenyl	92-52-4	NL	1,220	47,000	1,220	407	170	5,000
1,4-Dioxane	123-91-1	NL	NL	5,300	N/A	67	67	2,000
1,2,4,5-Tetrachlorobenzene	95-94-3	1,252	1,090	23,000	1,090	363	170	5,000
2,2'-oxybis(1-Chloropropane)	108-60-1	NL	NL	3,100,000	N/A	330	330	10,000
2,3,4,6-Tetrachlorophenol	58-90-2	NL	284	1,900,000	284	170	170	5,000
2,4,5-Trichlorophenol	95-95-4	NL	NL	6,300,000	N/A	170	170	5,000
2,4,6-Trichlorophenol	88-06-2	208	213	49,000	208	170	170	5,000
2,4-Dichlorophenol	120-83-2	81.7	117	190,000	82	82	170	5,000
2,4-Dimethylphenol	105-67-9	304	29	1,300,000	29	29	170	5,000
2,4-Dinitrophenol	51-28-5	6.21	NL	130,000	6.21	6.21	330	10,000
2,4-Dinitrotoluene	121-14-2	14.4	41.6	1,700	14.4	14.4	170	5,000
2,6-Dinitrotoluene	606-20-2	NL	NL	360	N/A	170	170	5,000
2-Chloronaphthalene	91-58-7	417	NL	4,800,000	417	170	170	5,000
2-Chlorophenol	95-57-8	31.9	31.2	390,000	31	31	170	5,000
2-Methylnaphthalene	91-57-6	70	20.2	240,000	20.2	20.2	170	5,000
2-Methylphenol	95-48-7	NL	NL	3,200,000	N/A	330	330	10,000
2-Nitroaniline	88-74-4	NL	NL	630,000	N/A	170	170	5,000
2-Nitrophenol	88-75-5	NL	NL	NL	N/A	170	170	5,000
3,3'-Dichlorobenzidine	91-94-1	127	127	1,200	127	127	330	10,000
3-Methylphenol*	108-39-4	NL	NL	3,200,000	N/A	N/A	NL	NL
3-Nitroaniline	99-09-2	NL	NL	NL	N/A	330	330	10,000
4,6-Dinitro-2-methylphenol	534-52-1	NL	NL	5,100	N/A	330	330	10,000
4-Bromophenyl-phenylether	101-55-3	NL	1,230	NL	1,230	410	170	5,000

QAPP WORKSHEET # 15n
Sediment Screening Criteria and PALs - SVOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (µg/kg)	Sediment PQLG (µg/kg)	CRQL - SOM02.4 Low Soil (µg/kg)	CRQL - SOM0.24 Medium Soil (µg/kg)
		NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil [c]				
4-Chloro-3-methylphenol	59-50-7	NL	NL	6,300,000	N/A	170	170	5,000
4-Chloroaniline	106-47-8	NL	NL	2,700	N/A	330	330	10,000
4-Chlorophenyl-phenyl ether	7005-72-3	NL	NL	NL	N/A	170	170	5,000
4-Methylphenol**	106-44-5	NL	670	6,300,000	670	330	330	10,000
4-Nitroaniline	100-01-6	NL	NL	27,000	N/A	330	330	10,000
4-Nitrophenol	100-02-7	13.3	NL	NL	13.3	13.3	330	10,000
Acenaphthene	83-32-9	16	6.7	3,600,000	6.7	6.7	170	5,000
Acenaphthylene	208-96-8	44	5.9	NL	5.9	5.9	170	5,000
Acetophenone	98-86-2	NL	NL	7,800,000	N/A	330	330	10,000
Anthracene	120-12-7	220	57.2	18,000,000	57	57	170	5,000
Atrazine	1912-24-9	NL	6.62	2,400	6.6	6.6	330	10,000
Benzaldehyde	100-52-7	NL	NL	170,000	N/A	330	330	10,000
Benzo(a)anthracene	56-55-3	320	108	1,100	108	200	170	5,000
Benzo(a)pyrene	50-32-8	370	150	110	150	150	170	5,000
Benzo(b)fluoranthene	205-99-2	10,400	NL	1,100	10,400	3,467	170	5,000
Benzo(g,h,i)perylene	191-24-2	170	170	NL	170	170	170	5,000
Benzo(k)fluoranthene	207-08-9	240	240	11,000	240	200	170	5,000
bis(2-Chloroethoxy) methane	111-91-1	NL	NL	190,000	N/A	170	170	5,000
bis(2-Chloroethyl) ether	111-44-4	3,520	NL	230	3,520	1,173	330	10,000
bis-(2-Ethylhexyl)phthalate	117-81-7	182	180	39,000	180	170	170	5,000
Butylbenzylphthalate	85-68-7	1,970	10,900	290,000	1,970	657	170	5,000
Caprolactam	105-60-2	NL	NL	31,000,000	N/A	330	330	10,000
Carbazole	86-74-8	NL	NL	NL	N/A	330	330	10,000
Chrysene	218-01-9	340	166	110,000	166	200	170	5,000
Dibenzo(a,h)anthracene	53-70-3	60	33	110	33	33	170	5,000
Dibenzofuran	132-64-9	NL	415	73,000	415	170	170	5,000

QAPP WORKSHEET # 15n
Sediment Screening Criteria and PALs - SVOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (µg/kg)	Sediment PQLG (µg/kg)	CRQL - SOM02.4 Low Soil (µg/kg)	CRQL - SOM0.24 Medium Soil (µg/kg)
		NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil [c]				
Diethylphthalate	84-66-2	295	603	51,000,000	295	170	170	5,000
Dimethylphthalate	131-11-3	NL	NL	NL	N/A	170	170	5,000
Di-n-butylphthalate	84-74-2	1,114	6,470	6,300,000	1,114	371	170	5,000
Di-n-octylphthalate	117-84-0	NL	NL	630,000	N/A	330	330	10,000
Fluoranthene	206-44-0	750	423	2,400,000	423	170	170	10,000
Fluorene	86-73-7	190	77.4	2,400,000	77.4	77.4	330	5,000
Hexachlorobenzene	118-74-1	20	20	210	20	20	170	5,000
Hexachlorobutadiene	87-68-3	26.5	NL	1,200	26.5	26.5	170	5,000
Hexachlorocyclopentadiene	77-47-4	901	NL	1,800	901	330	330	10,000
Hexachloroethane	67-72-1	584	1,027	1,800	584	195	170	5,000
Indeno(1,2,3-cd)pyrene	193-39-5	200	17	1,100	17	180	170	5,000
Isophorone	78-59-1	432	NL	570,000	432	200	170	5,000
Naphthalene	91-20-3	160	176	3,800	160	160	170	5,000
Nitrobenzene	98-95-3	145	NL	5,100	145	145	170	5,000
N-Nitroso-di-n-propylamine	86-30-6	NL	NL	110,000	N/A	170	170	5,000
N-Nitrosodiphenylamine	621-64-7	NL	2,680	78	2,680	893	170	5,000
Pentachlorophenol	87-86-5	23,000	504	1,000	504	330	330	10,000
Phenanthrene	85-01-8	560	204	NL	204	170	170	5,000

QAPP WORKSHEET # 15n
Sediment Screening Criteria and PALs - SVOCs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (µg/kg)	Sediment PQLG (µg/kg)	CRQL - SOM02.4 Low Soil (µg/kg)	CRQL - SOM0.24 Medium Soil (µg/kg)
		NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil [c]				
Phenol	108-95-2	49.1	420	19,000,000	49.1	49.1	330	10,000
Pyrene	129-00-0	490	195	1,800,000	195	170	170	5,000

Notes:

1. Sediment PALs were selected as the minimum value presented in a through c below.

(a) NJDEP Ecological Screening Criteria for the lowest effects level for fresh water criteria, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

(b) EPA Region 3 Freshwater Sediment Screening Benchmarks, August 2006 (<https://www.epa.gov/risk/freshwater-sediment-screening-benchmarks>)

(c) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), May 2016
(http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MA for SVOCs as they are not considered a primary compound of interest.

****4-Methylphenol** result will include 3-methylphenol since the isomers cannot be separated by the SOM02.4 extraction method and GC column used.

***3-Methylphenol** will need to be added via an MA [based on method 8041A or equivalent] to obtain result since this compound is not on the TCL.

CAS - Chemical Abstracts Service

CLP - contract laboratory program

CRQL - contract required quantitation limit

EPA - Environmental Protection Agency

MA - modified analysis

N/A - not applicable

NL - not listed

NJDEP - New Jersey Department of Environmental Protection

PAL - project action limit

PQLG - project quantitation limit goal

PRG - preliminary remediation goals

RSL - regional screening level

SVOCs - semivolatile organic compounds

µg/kg - microgram per kilogram

QAPP WORKSHEET # 15o
Soil Screening Criteria and PALs - Inorganics
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: mg/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (mg/kg)	Soil PQLG (mg/kg)	CRQL - ISM02.4 ICP-MS (mg/kg)	CRQL - ISM02.4 ICP-AES (mg/kg)
		NJDEP Residential Direct Contact Remediation Standard	EPA RSL for Residential Soil	EPA EcoSSLs	NJDEP Wildlife PRGs	PRGs for Ecological Endpoints	EPA Region 5				
Metals - ISM02.4											
Aluminum	7429-90-5	78,000	77,000	NL	NL	NL	NL	77,000	25,667	NL	20
Antimony	7440-36-0	31	31	0.27	5	5	0.142	0.142	0.142	1	6
Arsenic	7440-38-2	19	0.68	18	9.9	9.9	5.7	0.68	0.68	0.5	1
Barium	7440-39-3	16,000	15,000	330	283	283	1.04	1.04	1.04	5	20
Beryllium	7440-41-7	16	160	21	10	10	1.06	1.06	0.5	0.5	0.5
Cadmium	7440-43-9	78	71	0.36	4	4	0.00222	0.00222	0.00222	0.5	0.5
Calcium	7440-70-2	NL	NL	NL	NL	NL	NL	N/A	500	NL	500
Chromium	7440-47-3	NL	NL	26	0.4	0.4	0.4	0.4	0.4	1	1
Chromium (hexavalent)	18540-29-9	1	0.3	130	NL	NL	NL	0.3	0.3	1	1
Cobalt	7440-48-4	1,600	23	13	20	20	0.14	0.14	0.14	0.5	5
Copper	7440-50-8	3,100	3,100	28	60	60	5.4	5.4	2.5	1	2.5
Cyanide	57-12-5	680	2.3	NL	1.33	NL	1.33	1.33	0.5	0.5	0.5
Iron	7439-89-6	NL	55,000	NL	NL	NL	NL	55,000	18,333	NL	10
Lead	7439-92-1	200	200	11	40.5	40.5	0.0537	0.0537	0.0537	0.5	1
Magnesium	7439-95-4	NL	NL	NL	NL	NL	NL	N/A	N/A	NL	500
Manganese	7439-96-5	11,000	NL	220	NL	NL	NL	220	73	0.5	1.5
Mercury	7439-97-6	23	11	NL	0.00051	0.00051	0.1	0.00051	0.00051	NL	0.1
Nickel	7440-02-0	1,600	1,500	38	30	30	13.6	13.6	5	0.5	4
Potassium	7440-09-7	NL	NL	NL	NL	NL	NL	N/A	500	NL	500
Selenium	7782-49-2	390	390	0.52	0.21	0.21	0.0276	0.0276	0.0276	2.5	3.5
Silver	7440-22-4	390	390	4.2	2	2	4.04	2	1	0.5	1
Sodium	7440-23-5	NL	NL	NL	NL	NL	NL	N/A	500	NL	500
Thallium	7440-28-0	5	1	NL	1	1	0.0569	0.0569	0.0569	0.5	2.5
Vanadium	7440-62-2	78	390	7.8	2	2	1.59	1.59	1.59	2.5	5
Zinc	7440-66-6	23,000	23,000	46	8.5	8.5	6.62	6.62	6.62	1	6

QAPP WORKSHEET # 15o
Soil Screening Criteria and PALs - Inorganics
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: mg/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (mg/kg)	Soil PQLG (mg/kg)	CRQL - ISM02.4 ICP-MS (mg/kg)	CRQL - ISM02.4 ICP-AES (mg/kg)
		NJDEP Residential Direct Contact Remediation Standard	EPA RSL for Residential Soil	EPA EcoSSLs	NJDEP Wildlife PRGs	PRGs for Ecological Endpoints	EPA Region 5				
Additional Metals - EPA 1630 and BR3900, or equivalent											
Mercury speciation (BR3900 or equivalent)	7439-97-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Hg(F1), (F2) - 0.20*; Hg(F3)- Hg(F5) - 2.00*	Hg(F1), (F2) - 0.50*; Hg(F3)- Hg(F5) - 5.00*
Volatile Elemental Mercury (BR3900 or equivalent, modified)	7439-97-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20.0*	50.0*

Notes:

1. Soil PALs were selected as the minimum value presented in a through f below.

- (a) NJDEP Risk-based and remediation standard criteria for Residential Direct Contact Soil Remediation Standard, Last Amended May 2012 (<http://www.nj.gov/dep/srp/regs/rs/>)
- (b) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus
- (c) EPA Ecological Soil Screening Levels (EcoSSLs). <http://www.epa.gov/ecotox/ecoss/>
- (d) NJDEP Ecological Screening Criteria for the wildlife PRGs for soil, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)
When two values were presented in the table, the value based on a study was used.
- (e) Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals (PRGs) for Ecological Endpoints.
Prepared for the U.S. Department of Energy, Office of Environmental Management Contract No. DE-AC05-84OR21401.
- (f) EPA 2003. EPA Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels.

*Estimated detection limits and reporting limits provided by Brooks Applied Laboratories

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will request the existing CLP MAs for mercury (highlighted, as it is considered a primary compound of interest.

CLP - contract laboratory program
CRQL - contract required quantitation limit
EPA - Environmental Protection Agency
mg/kg - milligram per kilogram
MA - modified analysis
N/A - not applicable
NJDEP - New Jersey Department of Environmental Protection

NL - not listed
PAL - project action limits
PQLG - project quantitation limit goal
PRG - preliminary remediation goals
RCRA - resource conservation and recovery act
RSL - regional screening level
CAS - Chemical Abstracts Service

QAPP WORKSHEET # 15p
Sediment Screening Criteria and PALs - Inorganics
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: mg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (mg/kg)	Sediment PQLG (mg/kg)	CRQL - ISM02.4 ICP-MS (mg/kg)	CRQL - ISM02.4 ICP-AES (mg/kg)
		NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil [c]				
Metals - ISM02.4								
Aluminum	7429-90-5	25,500	NL	77,000	25,500	8,500	NL	20
Antimony	7440-36-0	3	2	31	2	2	1	6
Arsenic	7440-38-2	6	9.80	0.68	0.68	0.68	0.5	1
Barium	7440-39-3	48	NL	15,000	48	20	5	20
Beryllium	7440-41-7	NL	NL	160	160	53	0.5	0.5
Cadmium	7440-43-9	0.60	0.99	71	0.60	0.5	0.5	0.5
Calcium	7440-70-2	NL	NL	NL	N/A	500	NL	500
Chromium	7440-47-3	26	43.4	NL	26	8.7	1	1
Chromium (hexavalent)	18540-29-9	NL	50	0.3	0.3	0.3	1	1
Cobalt	7440-48-4	50	31.6	23	23	7.7	0.5	5
Copper	7440-50-8	16	0.10	3,100	0.10	0.10	1	2.5
Cyanide	57-12-5	0.0001	NL	NL	0.0001	0.0001	1	0.5
Iron	7439-89-6	NL	20,000	55,000	20,000	6,667	NL	10
Lead	7439-92-1	31	35.80	200	31	10	0.5	1
Magnesium	7439-95-4	NL	NL	NL	N/A	500	NL	500
Manganese	7439-96-5	630	460	NL	460	153	0.5	1.5
Mercury	7439-97-6	0.20	0.18	11	0.18	0.1	NL	0.1
Nickel	7440-02-0	16	22.7	1,500	16	5	0.5	4
Potassium	7440-09-7	NL	NL	NL	N/A	500	NL	500
Selenium	7782-49-2	NL	2	390	2	2	2.5	3.5
Silver	7440-22-4	1	1	390	1	1	0.5	1
Sodium	7440-23-5	NL	NL	NL	N/A	500	NL	500
Thallium	7440-28-0	NL	NL	0.78	0.78	0.78	0.5	2.5
Vanadium	7440-62-2	NL	NL	390	390	130	2.5	5
Zinc	7440-66-6	120	121	23,000	120	40	1	6

QAPP WORKSHEET # 15p
Sediment Screening Criteria and PALs - Inorganics
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: mg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (mg/kg)	Sediment PQLG (mg/kg)	CRQL - ISM02.4 ICP-MS (mg/kg)	CRQL - ISM02.4 ICP-AES (mg/kg)
		NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil [c]				
Additional Metals - EPA 1630 and BR3900, or equivalent								
Mercury speciation (BR3900 or equivalent)	7439-97-6	N/A	N/A	N/A	N/A	N/A	Hg(F1), (F2) - 0.20*; Hg(F3)- Hg(F5) - 2.00*	Hg(F1), (F2) - 0.50*; Hg(F3)- Hg(F5) - 5.00*
Volatile Elemental Mercury (BR3900 or equivalent, modified)	7439-97-6	N/A	N/A	N/A	N/A	N/A	20.0*	50.0*

Notes:

1. Sediment PALs were selected as the minimum value presented in a through c below.

(a) NJDEP Ecological Screening Criteria for the lowest effects level for fresh water criteria, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

(b) EPA Region 3 Freshwater Sediment Screening Benchmarks, August 2006 (<https://www.epa.gov/risk/freshwater-sediment-screening-benchmarks>)

(c) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), May 2016

(http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

*Estimated detection limits and reporting limits provided by Brooks Applied Laboratories

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will request the existing CLP MAs for mercury (highlighted, as it is considered a primary compound of interest.

CLP - contract laboratory program

CRQL - contract required quantitation limit

EPA - Environmental Protection Agency

mg/kg - milligram per kilogram

MA - modified analysis

N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection

NL - not listed

PAL - project action limits

PQLG - project quantitation limit goal

PRG - preliminary remediation goals

RCRA - resource conservation and recovery act

RSL - regional screening level

CAS - Chemical Abstracts Service

QAPP WORKSHEET # 15q
Soil Screening Criteria and PALs - Pesticides/PCBs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (µg/kg)	Soil PQLG (µg/kg)	CRQL - SOM02.4 Soil (µg/kg)
		NJDEP Residential Direct Contact Remediation Standard [a]	EPA RSL for Residential Soil [b]	EPA EcoSSLs [c]	NJDEP Wildlife PRGs [d]	PRGs for Ecological Endpoints [e]	EPA Region 5 [f]			
Pesticides										
4,4'-DDD	72-54-8	3,000	2,300	21	758	NL	758	21	7	3.3
4,4'-DDE	72-55-9	2,000	2,000	21	596	NL	596	21	7	3.3
4,4'-DDT	50-29-3	2,000	1,900	21	3.5	NL	3.5	3.5	3.3	3.3
Aldrin	309-00-2	40	39	NL	3.32	NL	3.32	3.32	1.7	1.7
alpha-BHC	319-84-6	100	86	NL	99.4	NL	99.4	86	28.7	1.7
beta-BHC	319-85-7	400	300	NL	3.98	NL	3.98	3.98	1.7	1.7
cis-Chlordane (alpha)	5103-71-9	200	1,700	NL	224	NL	224	200	66.7	1.7
delta-BHC	319-86-8	NL	570	NL	NL	NL	9,940	570	190	1.7
Dieldrin	60-57-1	40	34	4.9	2.38	NL	2.38	2.38	2.38	3.3
Endosulfan I	959-98-8	470,000	470,000	NL	NL	NL	119	119	40	1.7
Endosulfan II	33213-65-9	470,000	470,000	NL	NL	NL	119	119	40	3.3
Endosulfan sulfate	1031-07-8	470,000	470,000	NL	35.8	NL	35.8	35.8	12	3.3
Endrin	72-20-8	23,000	19,000	NL	10.1	NL	10.1	10.1	3.4	3.3
Endrin aldehyde	7421-93-4	NL	NL	NL	10.5	NL	10.5	10.5	3.5	3.3
Endrin ketone	53494-7-5	NL	NL	NL	NL	NL	NL	N/A	3.3	3.3
gamma-BHC (Lindane)	58-89-9	400	570	NL	5	NL	5	5	1.7	1.7
Heptachlor	76-44-8	100	130	NL	5.98	NL	5.98	5.98	1.7	1.7
Heptachlor epoxide	1024-57-3	70	70	NL	152	NL	152	70	23.3	1.7
Methoxychlor	72-43-5	390,000	320,000	NL	19.9	NL	19.9	19.9	17	17
Toxaphene	8001-35-2	600	490	NL	119	NL	119	119	119	170
trans-Chlordane (gamma)	5103-74-2	200	1,700	NL	224	NL	224	200	66.7	1.7
Polychlorinated Biphenyls (PCBs)										
Aroclor-1016	12674-11-2	200	4,100	NL	371	371	0.332	0.332	0.332	33
Aroclor-1221	11104-28-2	200	200	NL	371	371	0.332	0.332	0.332	33
Aroclor-1232	11141-16-5	200	170	NL	371	371	0.332	0.332	0.332	33
Aroclor-1242	53469-21-9	200	230	NL	371	371	0.332	0.332	0.332	33
Aroclor-1248	12672-29-6	200	230	NL	371	371	0.332	0.332	0.332	33
Aroclor-1254	11097-69-1	200	240	NL	371	371	0.332	0.332	0.332	33
Aroclor-1260	11096-82-5	200	240	NL	371	371	0.332	0.332	0.332	33
Aroclor-1262	37324-23-5	200	NL	NL	371	371	0.332	0.332	0.332	33
Aroclor-1268	11100-14-4	200	NL	NL	371	371	0.332	0.332	0.332	33

QAPP WORKSHEET # 15q
Soil Screening Criteria and PALs - Pesticides/PCBs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Notes:

1. Soil PALs were selected as the minimum value presented in a through f below.

(a) NJDEP Risk-based and remediation standard criteria for Residential Direct Contact Soil Remediation Standard, Last Amended May 2012 (<http://www.nj.gov/dep/srp/regs/rs/>)

(b) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus

(c) EPA Ecological Soil Screening Levels (EcoSSLs). <http://www.epa.gov/ecotox/ecossl/>

(d) NJDEP Ecological Screening Criteria for the wildlife PRGs for soil, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

When two values were presented in the table, the value based on a study was used.

(e) Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals (PRGs) for Ecological Endpoints.

Prepared for the U.S. Department of Energy, Office of Environmental Management Contract No. DE-AC05-84OR21401.

(f) EPA 2003. EPA Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels.

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MAs for pesticides or PCBs as they are not considered primary compounds of interest.

CLP - contract laboratory program

CRQL - contract required quantitation limit

EPA - Environmental Protection Agency

N/A - not applicable

NL - not listed

NJDEP - New Jersey Department of Environmental Protection

PAL - project action limits

PCBs - polychlorinated biphenyls

PQLG - project quantitation limit goal

PRG - preliminary remediation goals

RCRA - resource conservation and recovery act

RSL - regional screening level

µg/kg - microgram per kilogram

MA - modified analysis

CAS - Chemical Abstracts Service

QAPP WORKSHEET # 15r
Sediment Screening Criteria and PALs - Pesticides/PCBs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: µg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (µg/kg)	Sediment PQLG (µg/kg)	CRQL - SOM02.4 Soil (µg/kg)
		NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil [c]			
Pesticides							
4,4'-DDD	72-54-8	8	4.88	2,300	4.88	3.3	3.3
4,4'-DDE	72-55-9	5	3.16	2,000	3.16	3.16	3.3
4,4'-DDT	50-29-3	8	4.16	1,900	4.16	3.3	3.3
Aldrin	309-00-2	2	2	39	2	1.7	1.7
alpa-BHC	319-84-6	6	6	86	6	2	1.7
beta-BHC	319-85-7	5	5	300	5	1.7	1.7
cis-Chlordane (alpha)	5103-71-9	7	3.24	1,700	3.24	1.7	1.7
delta-BHC	319-86-8	NL	6,400	570	570	190	1.7
Dieldrin	60-57-1	2	1.9	34	1.9	1.9	3.3
Endosulfan I	959-98-8	NL	2.9	470,000	2.9	1.7	1.7
Endosulfan II	33213-65-9	NL	14	470,000	14	4.67	3.3
Endosulfan sulfate	1031-07-8	34.6	5.4	470,000	5.4	3.3	3.3
Endrin	72-20-8	3	2.22	19,000	2.22	2.22	3.3
Endrin aldehyde	7421-93-4	480	NL	NL	480	160	3.3
Endrin ketone	53494-7-5	NL	NL	NL	N/A	3.3	3.3
gamma-BHC (Lindane)	58-89-9	3	2.37	570	2.37	1.7	1.7
Heptachlor	76-44-8	0.6	68	130	0.6	0.6	1.7
Heptachlor epoxide	1024-57-3	5	2.47	70	2.47	1.7	1.7
Methoxychlor	72-43-5	13.6	18.7	320,000	13.6	13.6	17
Toxaphene	8001-35-2	0.077	0.1	490	0.077	0.077	170
trans-Chlordane (gamma)	5103-74-2	7	3.24	1,700	3.24	1.7	1.7
Polychlorinated Biphenyls (PCBs)							
Aroclor-1016	12674-11-2	7	59.8	4,100	7	7	33
Aroclor-1221	11104-28-2	70	59.8	200	59.8	33	33
Aroclor-1232	11141-16-5	70	59.8	170	59.8	33	33
Aroclor-1242	53469-21-9	70	59.8	230	59.8	33	33
Aroclor-1248	12672-29-6	30	59.8	230	30	30	33
Aroclor-1254	11097-69-1	60	59.8	240	59.8	33	33
Aroclor-1260	11096-82-5	5	59.8	240	5	5	33
Aroclor-1262	37324-23-5	70	59.8	NL	59.8	33	33
Aroclor-1268	11100-14-4	70	59.8	NL	59.8	33	33

QAPP WORKSHEET # 15r
Sediment Screening Criteria and PALs - Pesticides/PCBs
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Notes:

1. Sediment PALs were selected as the minimum value presented in a through c below.
 - (a) NJDEP Ecological Screening Criteria for the lowest effects level for fresh water criteria, March 2009
 - (b) EPA Region 3 Freshwater Sediment Screening Benchmarks, August 2006 (<https://www.epa.gov/risk/freshwater-sediment-screening>).
 - (c) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), May 2016 (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MAs for pesticides or PCBs as they are not considered primary compounds of interest.

CAS - Chemical Abstracts Service
CLP - contract laboratory program
CRQL - contract required quantitation limit
EPA - Environmental Protection Agency
MA - modified analysis
N/A - not applicable
NL - not listed
NJDEP - New Jersey Department of Environmental Protection

PAL - project action limits
PCBs - polychlorinated biphenyls
PQLG - project quantitation limit goal
PRG - preliminary remediation goals
RCRA - resource conservation and recovery act
RSL - regional screening level
µg/kg - microgram per kilogram

QAPP WORKSHEET # 15s
Soil Screening Criteria and PALs - Dioxins/Furans
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierison's Creek Site OU1
Newark, New Jersey

Analyte (All Units: ng/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (ng/kg)	Soil PQLG (ng/kg)	CRQL - HRSM01.2 (ng/kg)
		NJDEP Residential Direct Contact Remediation Standard [a]	EPA RSL for Residential Soil [b]	EPA EcoSSLs [c]	NJDEP Wildlife PRGs [d]	PRGs for Ecological Endpoints [e]	EPA Region 5 [f]			
2,3,7,8-TCDD	1746-01-6	NL	4.8	NL	3.15	NL	0.12	0.12	0.12	1.0
1,2,3,7,8-PeCDD	40321-76-4	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,7,8-HxCDD	39227-28-6	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,6,7,8-HxCDD	57653-85-7	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,7,8,9-HxCDD	19408-74-3	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,6,7,8-HpCDD	35822-46-9	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
OCDD	3268-87-9	NL	NL	NL	NL	NL	NL	N/A	N/A	10
2,3,7,8-TCDF	51207-31-9	NL	NL	NL	NL	NL	NL	N/A	N/A	1.0
1,2,3,7,8-PeCDF	57117-41-6	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
2,3,4,7,8-PeCDF	57117-31-4	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,7,8-HxCDF	70648-26-9	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,6,7,8-HxCDF	57117-44-9	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,7,8,9-HxCDF	72918-21-9	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
2,3,4,6,7,8-HxCDF	60851-34-5	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,6,7,8-HpCDF	67562-39-4	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,7,8,9-HpCDF	55673-89-7	NL	NL	NL	NL	NL	NL	N/A	N/A	5.0
OCDF	39001-02-0	NL	NL	NL	NL	NL	NL	N/A	N/A	10

QAPP WORKSHEET # 15s
Soil Screening Criteria and PALs - Dioxins/Furans
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Notes:

1. Soil PALs were selected as the minimum value presented in a through f below.

(a) NJDEP Risk-based and remediation standard criteria for Residential Direct Contact Soil Remediation Standard, Last Amended May 2012 (<http://www.nj.gov/dep/srp/regs/rs/>)

(b) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus

(c) EPA Ecological Soil Screening Levels (EcoSSLs). <http://www.epa.gov/ecotox/ecossl/>

(d) NJDEP Ecological Screening Criteria for the wildlife PRGs for soil, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

When two values were presented in the table, the value based on a study was used.

(e) Efromson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals (PRGs) for Ecological Endpoints.

Prepared for the U.S. Department of Energy, Office of Environmental Management Contract No. DE-AC05-84OR21401.

(f) EPA 2003. EPA Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels.

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request the existing CLP MAs for dioxins/furans as they are not considered primary compounds of interest.

CAS - Chemical Abstracts Service

CLP - contract laboratory program

CRQL - contract required quantitation limit

EPA - Environmental Protection Agency

MA - modified analysis

N/A - not applicable

ng/kg - nanogram per kilogram

NJDEP - New Jersey Department of Environmental Protection

NL - not listed

PAL - project action limits

PQLG - project quantitation limit goal

PRG - preliminary remediation goals

RCRA - resource conservation and recovery act

RSL - regional screening level

QAPP WORKSHEET # 15t
Sediment Screening Criteria and PALs - Dioxins/Furans
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: ng/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment Screening Criteria (ng/kg)	Sediment PAL (ng/kg)	Sediment PQLG (ng/kg)	CRQL - HRSM01.2 (ng/kg)
		NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil [c]				
2,3,7,8-TCDD	1746-01-6	0.128	0.85	4.8	0.128	0.128	0.128	1.0
1,2,3,7,8-PeCDD	40321-76-4	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,7,8-HxCDD	39227-28-6	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,6,7,8-HxCDD	57653-85-7	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,7,8,9-HxCDD	19408-74-3	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,6,7,8-HpCDD	35822-46-9	NL	NL	NL	NL	N/A	N/A	5.0
OCDD	3268-87-9	NL	NL	NL	NL	N/A	N/A	10
2,3,7,8-TCDF	51207-31-9	NL	NL	NL	NL	N/A	N/A	1.0
1,2,3,7,8-PeCDF	57117-41-6	NL	NL	NL	NL	N/A	N/A	5.0
2,3,4,7,8-PeCDF	57117-31-4	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,7,8-HxCDF	70648-26-9	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,6,7,8-HxCDF	57117-44-9	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,7,8,9-HxCDF	72918-21-9	NL	NL	NL	NL	N/A	N/A	5.0
2,3,4,6,7,8-HxCDF	60851-34-5	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,6,7,8-HpCDF	67562-39-4	NL	NL	NL	NL	N/A	N/A	5.0
1,2,3,4,7,8,9-HpCDF	55673-89-7	NL	NL	NL	NL	N/A	N/A	5.0
OCDF	39001-02-0	NL	NL	NL	NL	N/A	N/A	10

Notes:

1. Sediment PALs were selected as the minimum value presented in a through c below.

(a) NJDEP Ecological Screening Criteria for the lowest effects level for fresh water criteria, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

(b) EPA Region 3 Freshwater Sediment Screening Benchmarks, August 2006 (<https://www.epa.gov/risk/freshwater-sediment-screening-benchmarks>)

(c) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), May 2016

(http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

Bolded values indicate PQLGs are less than the CRQL. CDM Smith will not request an MA for dioxins/furans as they are not considered primary compounds of interest.

CLP - contract laboratory program

CRQL - contract required quantitation limit

EPA - Environmental Protection Agency

MA - modified analysis

N/A - not applicable

ng/kg - nanogram per kilogram

NJDEP - New Jersey Department of Environmental Protection

NL - not listed

PAL - project action limits

PQLG - project quantitation limit goal

PRG - preliminary remediation goals

RCRA - Resource Conservation and Recovery Act

RSL - regional screening level

CAS - Chemical Abstracts Service

QAPP WORKSHEET # 15u
Soil Screening Criteria and PALs - Wet Chemistry
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: mg/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (mg/kg)	Soil PQLG (mg/kg)	RL - (mg/kg)
		NJDEP Residential Direct Contact Remediation Standard [a]	EPA RSL for Residential Soil [b]	EPA EcoSSLs [c]	NJDEP Wildlife PRGs [d]	PRGs for Ecological Endpoints [e]	EPA Region 5 [f]			
Grain Size	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TOC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100
Percent Solids	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Methylmercury - EPA 1630										
Analyte (All Units: µg/kg)	CAS Number	Human Health Screening Criteria		Ecological Screening Criteria				Soil PAL (µg/kg)	Soil PQLG (µg/kg)	RL - (µg/kg)
		NJDEP Residential Direct Contact Remediation Standard	EPA RSL for Residential Soil	EPA EcoSSLs	NJDEP Wildlife PRGs	PRGs for Ecological Endpoints	EPA Region 5			
Methylmercury	22967-92-6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.1	0.1

Notes:

1. Soil PALs were selected as the minimum value presented in a through f below.

(a) NJDEP Risk-based and remediation standard criteria for Residential Direct Contact Soil Remediation Standard, Last Amended May 2012 (<http://www.nj.gov/dep/srp/regs/rs/>)

(b) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), June 2017. The lower value of the RSLs derived from cancer versus

(c) EPA Ecological Soil Screening Levels (EcoSSLs). <http://www.epa.gov/ecotox/ecoss/>

(d) NJDEP Ecological Screening Criteria for the wildlife PRGs for soil, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

When two values were presented in the table, the value based on a study was used.

(e) Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals (PRGs) for Ecological Endpoints.

Prepared for the U.S. Department of Energy, Office of Environmental Management Contract No. DE-AC05-84OR21401.

(f) EPA 2003. EPA Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels.

CAS - Chemical Abstracts Service

EPA - Environmental Protection Agency

mg/kg - milligram per kilogram

N/A - not applicable

NJDEP - New Jersey Department of Environmental Protection

PAL - project action limits

PQLG - project quantitation limit goal

PRG - preliminary remediation goals

RCRA - Resource Conservation and Recovery Act

RL - required limit

RSL - regional screening level

QAPP WORKSHEET # 15v
Sediment Screening Criteria and PALs - Wet Chemistry
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: mg/kg)	CAS Number	Ecological Screening Criteria		Human Health Screening Criteria	Sediment PAL (mg/kg)	Sediment PQLG (mg/kg)	RL - (mg/kg)
		NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil [c]			
Grain Size	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TOC	N/A	N/A	N/A	N/A	N/A	N/A	100
Percent Solids	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Methylmercury - EPA 1630							
Analyte (All Units: µg/kg)	CAS Number	NJDEP Fresh Water [a]	EPA Region 3 Freshwater [b]	EPA RSL for Residential Soil	Sediment PAL (mg/kg)	Sediment PQLG (mg/kg)	RL - (µg/kg)
Methylmercury	22967-92-6	N/A	N/A	N/A	N/A	0.1	0.1

Notes:

1. Sediment PALs were selected as the minimum value presented in a through c below.

(a) NJDEP Ecological Screening Criteria for the lowest effects level for fresh water criteria, March 2009 (<http://www.nj.gov/dep/srp/guidance/ecoscreening/>)

(b) EPA Region 3 Freshwater Sediment Screening Benchmarks, August 2006 (<https://www.epa.gov/risk/freshwater-sediment-screening-benchmarks>)

(c) EPA Human health-based screening – RSL residential soil values (Target Risk = 1E-06; Target Hazard Quotient = 1), May 2016

(http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm)

CAS - Chemical Abstracts Service

EPA - Environmental Protection Agency

N/A - not applicable

mg/kg - milligram per kilogram

NJDEP - New Jersey Department of Environmental Protection

PAL - project action limits

PQLG - project quantitation limit goal

PRG - preliminary remediation goals

RL - required limit

RSL - regional screening level

QAPP WORKSHEET # 15x
Vapor/Air Screening Criteria and PAL - Mercury
Project Action Limits and Laboratory-Specific Detection/Quantitation Limits
Pierson's Creek Site OU1
Newark, New Jersey

Analyte (All Units: mg/m ³)	CAS Number	OSHA PEL (mg/m ³)	NIOSH REL (mg/m ³)	ACGIH TLV (mg/m ³)	Residential Air RSL (mg/m ³)	Industrial Air RSL (mg/m ³)	Vapor/Air PAL (mg/m ³)	Vapor/Air PQLG (mg/m ³)	RL - (mg/m ³)
Mercury	7439-97-6	0.1	0.05	0.025	0.00031	0.0013	N/A	0.01	0.01

Notes:

1. No PAL was selected for mercury in vapor/air because the purpose of the sampling is to determine if mercury (at any concentration) is volatilizing from the soil to the air.

The following standards and criteria are included in the table for reference.

(a) OSHA permissible exposure limits (<https://www.osha.gov/dsg/annotated-pels/tablez-2.html>)

(b) NIOSH recommended exposure limits (<https://www.cdc.gov/niosh/npg/npgd0383.html>)

(c) ACGIH threshold limit value (<https://www.acgih.org/>)

(d) EPA RSL for industrial air, associated with the a noncancer hazard index of 1. (<https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables>)

ACGIH - American Conference of Governmental Industrial Hygienists

CAS - Chemical Abstracts Service

EPA - Environmental Protection Agency

mg/m³ - milligram per meter cubed

N/A - not applicable

NIOSH - National Institute for Occupational Safety and Health

NJDEP - New Jersey Department of Environmental Protection

OSHA - Occupational Safety and Health Administration

PAL - project action limit

PEL - permissible exposure limit

PQLG - project quantitation limit goal

PRG - preliminary remediation goal

REL - recommended exposure limit

RL - required limit

RSL - regional screening level

TLV - threshold limit value

QAPP Worksheet #17: Sampling Design and Rationale
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

The RI field program is detailed on the following worksheets:

- Site Reconnaissance (**Worksheet #17a**)
- Mobilization/Demobilization (**Worksheet #17b**)
- Monitoring Well Drilling and Installation (**Worksheet #17c**)
- Staff Gauge Installation, Synoptic Water Levels, and Long-Term Water Level Measurements (**Worksheet #17d**)
- Sediment Sampling (**Worksheet #17e**)
- Surface Water Sampling (**Worksheet #17f**)
- Soil Sampling (**Worksheet #17g**)
- Groundwater Sampling (**Worksheet #17h**)
- Decontamination Procedures (**Worksheet #17i**)

Note: All CDM Smith Technical Standard Operation Procedures (Technical SOPs) are provided in **Appendix A**. Field forms are included in **Appendix B**.

For Technical SOP 4-1, *Field Logbook Content and Control*, the logbook notes should include field procedures used; descriptions of photos taken; problems encountered; notes of conversations with onsite and offsite project team members; details of samples collected, and visual observations.

QAPP Worksheet #17a: Sampling Design and Rationale
Site Reconnaissance
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Site Reconnaissance

CDM Smith will conduct an initial reconnaissance of the entire length of Pierson's Creek to finalize sample locations and determine the necessary property and logistical access to each sampling area. All proposed sediment transects, monitoring wells, and soil boring locations will be located with global positioning system (GPS) and marked with stakes, paint, or flagging, as appropriate. In addition, existing features in the site area will be surveyed during site reconnaissance including existing monitoring wells, storm sewers, seeps, culverts, buried portions of the creek, and possible point/non-point source discharges to the creek. CDM Smith will take representative photographs to document the reconnaissance activities and significant events or observations during the RI field program.

Site Survey

CDM Smith will oversee a subcontract survey crew which will perform a topographic and bathymetric survey covering property boundaries, utility rights-of-way, channel dimensions of Pierson's Creek and its drainage ditches, locations and elevations of culverts, location of manholes, topography, site features, property boundary and monitoring wells. It is assumed that the six existing and 24 new monitoring wells will be surveyed for locations and elevations of the land surface, protective pad, top of the outer protective casing, and the top of the inner polyvinyl chloride (PVC) casing. In addition, the seven new staff gauges will be surveyed for locations and elevations of the land surface and top of casing.

Cultural Resources Survey

In accordance with the National Historical Preservation Act, a Phase IA cultural resources survey will be conducted to determine the presence or absence of cultural resources that may be impacted by the implementation of the RI field program or subsequent remedial actions. CDM Smith will oversee the subcontract cultural resources survey crew performing the survey.

Field Procedures for these activities are detailed in:

- Technical SOP 3-2 Topographic Survey
- Technical SOP 4-1 Field Logbook Content and Control
- Technical SOP 4-2 Photographic Documentation of Field Activities

QAPP Worksheet #17b: Sampling Design and Rationale
Mobilization/Demobilization
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Procurement of Technical Services

CDM Smith will procure subcontractors for a base map survey, drilling services, cultural resources, and IDW disposal in accordance with the Federal Acquisition Regulation and CDM Smith procedures. A scope of work will be prepared for services procured by CDM Smith and will include the project's technical and quality standards to meet the requirements established herein. CDM Smith will follow the FASTAC procedure in procurement of subcontractor laboratory(ies) for the analyses not provided by DESA or CLP laboratories (i.e. complex mercury analyses).

Site Access Support and Site Access

EPA will be responsible for obtaining necessary site access to execute the field investigation. CDM Smith will assist EPA with site access if necessary. CDM Smith will provide a list of owners of properties (public and private) to be accessed during the field activities. The list will include the mailing addresses and telephone numbers of the property owners. Coordination with property owners, local officials, and appropriate City of Newark agencies (for work in public areas) may be necessary to support sampling activities. Once EPA has established that access has been granted, sampling activities can begin.

Field Planning Meetings

Prior to field mobilization, each field team member will review the associated project plans (e.g., work plan, QAPP, health and safety plan [HASP]) and participate in a field planning meeting conducted by the CDM Smith SM or designee. This field planning meeting will address Site history, health and safety requirements, roles and responsibilities, field procedures, field data collection and management procedures, sample location and sample naming, communication procedures, and related QC requirements. CDM Smith field personnel will also attend an onsite tailgate kick-off meeting immediately prior to the commencement of each stage or step of field activities. All new field personnel will receive a comparable briefing if they were not at the initial field planning meeting and/or the tailgate kick-off meeting. Supplemental meetings may be conducted as required by any changes in site conditions or to review field operation procedures.

The CDM Smith DC will work with the sample manager to prepare the Scribe file and identify the required field EDDs to ensure consistency with database format. The DC will review the analytical method codes used in Scribe to ensure they are consistent with EQUIS.

Field Equipment and Supplies

Equipment and field supply mobilization, governed by CDM Smith's Quality Procedures (QP) 6.3, Procuring Measurement and Test Equipment, Section 7 addresses ordering, renting, and purchasing of all supplies needed for each part of the investigation.

**QAPP Worksheet #17b: Sampling Design and Rationale
Mobilization/Demobilization (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)**

Field Trailer, Utilities, and Services

Arrangements for a field trailer, utilities, storage area for IDW, trash container, and portable sanitary facilities will be made. The command post area must be large enough to accommodate a 40-foot office trailer, at least one 20-cubic-yard roll-off container, one 20,000-gallon Baker tank, portable sanitary facilities, a decontamination area, drilling equipment and associated supplies, drill rigs and subcontractor support vehicles, and vehicles. Local authorities such as the police and fire departments will be notified prior to the start of field activities. In addition, arrangements for 24 hours/7 days per week security will be made to minimize damage and theft at the site.

IDW

IDW generated during the RI field activities will consist of sediment, soil, surface water, well purge water, decontamination water, disposable PPE, and general municipal solid waste. Used PPE and general municipal solid waste will be collected in garbage bags and disposed of as solid municipal waste. Contaminated or potentially contaminated IDW will be segregated from uncontaminated IDW. Within the contaminated IDW, sediment/soil IDW suspected of having elevated mercury concentrations will be kept separate in efforts to minimize IDW disposal costs. Water and sediment/soil IDW will be containerized in closed-top 55-gallon drums and stored at a secure location on site pending disposal. Containers will be labeled with the site name, boring/monitoring well number, description of contents, and dates of collection. Representative waste samples will be collected and analyzed by a laboratory to characterize the IDW. All off-site disposal facilities will be cleared under EPA's off-site disposal rule (OSR); the OSR form will be sent for EPA's review. CDM Smith will contact EPA prior to disposal to ensure the selected disposal facility meets the OSR.

Field Change Notifications

If deviations from this QAPP are required they will be documented on a field change notification (FCN) form, discussed with the EPA RPM, and approved by EPA before the change is implemented. Any associated impact on the project's quality objectives will be documented on the form. Deviations from this QAPP also will be discussed in any applicable technical report(s).

For minor changes, an FCR form will be prepared and sent to the EPA. For major changes, CDM Smith will prepare a QAPP Addendum after discussing the change with EPA. It is the responsibility of the FTL to notify the SM of necessary changes. The SM and the QAS will determine whether changes to the UFP-QAPP are required and, if so, to communicate these changes to the EPA.

**QAPP Worksheet #17b: Sampling Design and Rationale
Mobilization/Demobilization (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)**

Site Visit and Utility Location

Prior to the start of the drilling program, CDM Smith and the drilling subcontractor will visit all proposed drilling locations at the Site to ensure they are marked and accessible by the subcontractor's equipment and free from overhead utility lines. Location information for the proposed borings will be recorded using a hand-held GPS unit. The subcontractor will contact the appropriate local utility or "one-call" service to locate subsurface utility lines in the vicinity of proposed borehole locations. If the utility locating service indicates the proposed drilling location must be moved, then CDM Smith will move the location in consultation with EPA. Utilities will be marked in the field and locations documented via photographs and field notes.

Field Procedures for these activities are detailed in:

- Technical SOP 4-1 Field Logbook Content and Control
- Technical SOP 4-2 Photographic Documentation of Field Activities

QAPP Worksheet #17c: Sampling Design and Rationale
Monitoring Well Drilling and Installation
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Monitoring wells will be installed on either side of Pierson's Creek to straddle the water table, which is expected to be encountered between 2 and 6 feet bgs. Existing and proposed monitoring wells are shown in Figures 2, 3, and 4. All drilling will be conducted using hollow-stem auger (HSA) methods with 4.25-inch inside diameter (I.D.) augers. Wells will be drilled to a depth of approximately 15 to 20 feet bgs with a well screen of 10 feet in length in order to screen the shallow groundwater on either side of the creek. Well installation methods and the intervals screened may be adjusted based on access and the depth to water at each proposed location. Split-spoon samples will be collected continuously from the surface to total depth in each well. The split-spoon samples lithology will be logged by the onsite geologist and scanned with a photoionization detector (PID) and a mercury vapor analyzer. Soil cores collected during monitoring well drilling will not be sent to the laboratory for analysis. To help gain geological information about the Site, descriptions of field observations, measurements and notes will be recorded. Where applicable, information such as (but not limited to) texture (grain-size distribution, particle angularity, sorting, packing), color, degree of consolidation, moisture content, significant changes in lithology (sharp and gradational), and matrix composition should be recorded in the field logbook or lithological log form per Technical SOPs 3-5 and 4-1. Wells will be completed with heavy duty 6-inch diameter flush-mount curb boxes and fitted with lockable compression plugs.

Twenty-four (24) monitoring wells will be installed as shown on Figures 2, 3, and 4 and described below. Final locations are to be determined following site reconnaissance.

- Eight shallow monitoring wells in the Upper Creek Section. The wells will be installed in two transects of four monitoring wells each consisting of two monitoring wells on either side of the creek.
- Twelve shallow monitoring wells in the Middle Creek Section. The wells will be installed in three transects of four monitoring wells each consisting of two monitoring wells on either side of the creek.
- Four shallow monitoring wells in the Lower Creek Section. The wells will be installed in two transects of two monitoring wells each consisting of one monitoring well on either side of the creek.

Prior to the start of monitoring well installation activities, CDM Smith and the drilling subcontractor will visit all proposed drilling locations to ensure that they are marked and accessible by the subcontractor's equipment and free from overhead utility lines. CDM Smith will use a hand-held GPS unit to navigate and mark proposed boring locations with preset coordinates. The subcontractor will contact the appropriate local utility or "one-call" service to locate subsurface utility lines in the vicinity of proposed borehole locations. Final boring location coordinate information will be recorded at completion.

**QAPP Worksheet #17c: Sampling Design and Rationale
Monitoring Well Drilling and Installation (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)**

In addition to the “one-call” service, the drilling subcontractor will contact a representative from the utility company to verify the locations of any pipes and electrical lines that may be present beneath the Site. Utilities will be marked in the field and locations documented via photographs and field notes. If the utility locating service indicates the proposed drilling location must be moved, then CDM Smith will move the location in consultation with EPA.

Well Development

Monitoring well development will be performed in accordance with Technical SOP 4-3 to remove sand, silt and water used during drilling from the well and sand pack and to “set” the sand pack to provide a good hydraulic connection between the well and the aquifer materials. In accordance with SOP 4-3, the grout will be allowed to set for a minimum of 48 hours before well development proceeds. Turbidity, pH, temperature, conductivity, and dissolved oxygen will be monitored during development. Development will continue until a turbidity of 50 nephelometric turbidity units (NTUs) is achieved or until all parameters have stabilized (within 10 percent for measurements on successive casing volumes) or as approved by the on-site geologist or engineer.

Monitoring wells will be developed by pumping and surging methods, using a pump capable of producing rates of 1-10 gallons per minute (gpm) at a minimum head of 50 feet. Note that if wells do not recover adequately, they will be purged dry (or to within 1 to 5 feet of the top of the screen) a minimum three times, prior to sampling. If the well does not stabilize within 2 hours and if three successive readings fall within the required range, the SM will be notified and the sample will be collected. If wells become dry prior to stabilization or if water quality parameters will not stabilize, CDM Smith will utilize alternative development methods as described in SOP 4-3.

Well Survey

Newly installed monitoring wells will be surveyed by a surveying subcontractor to obtain the following measurements:

- Horizontal and vertical locations of a permanently installed surveyor’s mark in the drainage apron
- Elevation of a permanently installed surveyor’s mark in the drainage apron
- Elevation of a permanently installed surveyor’s mark on the inner riser casing
- Survey measurements in latitude/longitude and northing/easting

Associated Field Procedures for these Activities are detailed in:

- Technical SOP 1-2 Sample Custody
- Technical SOP 1-4 Subsurface Soil Sampling

**QAPP Worksheet #17c: Sampling Design and Rationale
Monitoring Well Drilling and Installation (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)**

Associated Field Procedures (continued):

- Technical SOP 1-6 Groundwater Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators (and manufacturer's instructions)
- Technical SOP 1-10 Field Measurement of Organic Vapors
- Technical SOP 2-1 Packaging and Shipping of Environmental Samples
- Technical SOP 2-2 Guide to Handling of Investigation Derived Waste
- Technical SOP 3-5 Lithological Logging
- Technical SOP 4-1 Field Logbook Content and Control
- Technical SOP 4-2 Photographic Documentation of Field Activities
- Technical SOP 4-3 Well Development and Purging
- Technical SOP 4-4 Design and Installation of Monitoring Wells in Aquifers
- Worksheet 17i Decontamination Procedures
- Worksheet 18 Sampling Locations and Methods/SOP Requirements
- Worksheet 19 Sample Containers, Preservation, and Hold Times
- Worksheet 20 Field Quality Control Summary
- Worksheet 22 Field Equipment Calibration, Maintenance, Testing, and Inspection

QAPP Worksheet #17d: Sampling Design and Rationale
Staff Gauge Installation, Synoptic Water Levels, and Long-Term Water Level Measurements
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Staff Gauge Installation

Seven staff gauges will be installed adjacent to each of the seven monitoring well transects so that accurate groundwater and creek water elevations can be determined. These readings will be compared to evaluate the gaining and losing characteristics of the stream. If staff gauges cannot be installed effectively, installation of stilling wells will be evaluated.

Synoptic Water Levels

Four rounds of synoptic water level measurements will be conducted at the start of each groundwater sampling round and concurrent with both the dry and wet weather surface water sampling. Collecting synoptic water levels during all events will aid in understanding seasonal fluctuations of water level elevations. Synoptic water level measurements will be collected at the 24 new and 6 existing monitoring wells, and the assumed 7 staff gauges/stilling wells.

Water level measurements will be collected from each monitoring well using an electronic water level indicator, at the surveyor's mark on the inner casing. The total depth of each well will also be recorded. If more than one electronic water level indicator is used, they will be checked against each other for accuracy. The field sampling team will use a PID to measure the VOC concentration at the well head prior to collecting water level measurements. The Well Assessment Checklist in Appendix B will be completed upon arrival at each well during the synoptic water level measurement event.

Long-Term Water Level Measurements

Long-term water level monitoring data will be collected to evaluate temporal fluctuations in water levels. Long-term groundwater level monitoring will be conducted at Transect 1 (Figure 2) and Transect 10 (Figure 3) over a period of four weeks. Data will be collected using in-situ vented water level monitoring instruments such as the TROLL 500 or equivalent. The specifications sheet and the manual for the TROLL 500 are included in Appendix C. Barometric pressure will be recorded at one of the transects. To provide baseline water levels and to verify the water level measurements, manual water levels will be collected at the start, midpoint, and conclusion of monitoring. At the midpoint of the monitoring period, the data will be downloaded and checked. At the end of the monitoring period, the data will be downloaded and stored for evaluation. Precipitation data for the monitoring period will be obtained from a local weather station.

QAPP Worksheet #17d: Sampling Design and Rationale
Staff Gauge Installation, Synoptic Water Levels, and Long-Term Water Level Measurements
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Associated Field Procedures for these Activities are detailed in:

- Technical SOP 1-6 Groundwater Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators (and manufacturer's instructions)
- Technical SOP 2-2 Guide to Handling of Investigation Derived Waste
- Technical SOP 4-1 Field Logbook Content and Control
- Technical SOP 4-2 Photographic Documentation of Field Activities
- Technical SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites
- Worksheet 17i Decontamination Procedures
- Worksheet 22 Field Equipment Calibration, Maintenance, Testing, and Inspection

QAPP Worksheet #17e: Sampling Design and Rationale
Sediment Sampling
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

The purpose of the sediment sampling is to delineate the horizontal and vertical extent of contamination in sediment present in Pierson's Creek and its drainage ditches. Prior to the start of sediment sampling activities, all proposed sample locations will be reviewed as described in Worksheet #17b. A summary of sediment sampling and analyses is presented in Table 1.

Upper, Middle, and Lower Creek Sections

Sediment cores will be advanced using DPT sampling techniques. Before boring advancement, the width of the channel will be measured, and the boring will be collected at the location within the baseflow channel which has the greatest accumulation of sediment. Seven analytical samples will be collected from each boring at depths of 0 to 0.5-foot, 0.5 foot to 1 foot, 1 to 2 feet, 2 to 3 feet, 3 to 4 feet, 4 to 5 feet, and the top 6 inches of native sediment (if encountered). Samples will be taken at these intervals to vertically delineate any potential contamination and understand the mobility of contaminants in the sediment column. Sediment samples will be spaced approximately 100 feet apart along Pierson's Creek and approximately 200 feet apart along the drainage ditches in the upper, middle, and lower creek section. In the culverted section, sediment samples will be spaced approximately 500 feet apart.

A total of 13 borings will be advanced in the Upper Creek Section. Sediment borings will be advanced as follows:

- Three borings will be advanced in the drainage ditch that runs along the eastern border of Troy Chemical.
- Six borings will be advanced in the portion of Pierson's Creek that runs through the United States Freightways Corporation (USF) Redstar property. Two borings will be advanced at each monitoring well transect for a total of four borings, while the other two borings are located in between the two monitoring well transects.
- Four borings will be advanced in the creek slope at the monitoring well transects. Each transect will have two borings with one on either side of the creek.

A total of 23 borings will be advanced in the Middle Creek Section. Sediment borings will be advanced as follows:

- Two borings will be advanced in the eastern drainage ditch, and one boring will be advanced where the eastern drainage ditch feeds into Pierson's Creek.
- Two borings will be advanced in the western drainage ditch, and one boring will be advanced where the western drainage ditch feeds into Pierson's Creek.
- Two borings will be advanced at each monitoring well transect for a total of six borings.
- Five borings will be advanced along the creek in between the monitoring well transects.
- Six borings will be advanced in the creek slope at the monitoring well transects. Each transect will have two borings with one boring on either side of the creek.

QAPP Worksheet #17e: Sampling Design and Rationale
Sediment Sampling (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Upper, Middle, and Lower Creek Sections (continued)

A total of 15 borings will be advanced in the Lower Creek Section. Sediment borings will be advanced as follows:

- Two borings will be advanced in each of the three drainage ditches in this section for a total of six borings.
- One boring will be advanced where each of the three drainage ditches feeds into Pierson's creek for a total of three borings.
- Five borings will be advanced in the portion of Pierson's creek that runs along the southern border of the long-term airport parking areas.
- One boring will be advanced in Pierson's Creek on the northern side of the Conrail Oak Island Rail Yard.

Lower Creek Section/Culverted Section

Sediment samples from within the lower creek section/culverted section will be grab samples from the top 0.5 feet of sediment, if available. Eight samples are anticipated in this area, however they are not shown on the sampling figures as access is currently undetermined. Remotely operated vehicles (ROVs) may be necessary to collect samples from the underground portions of Pierson's Creek.

Mercury Vapor Sampling

Ambient air samples for mercury vapor will be collected at locations along the banks of the open portions (i.e. not culverted sections) of Pierson's Creek. Samples will be collected at each sediment sampling transect using the sampling train that includes an air sample pump, airflow calibrator, sorbent sample tube, and an appropriate protective tube cover. The air sample pump will be set to a flow rate between 0.15 and 0.25 L/min using the air flow calibrator. Once the pump is hooked up to the sorbent tube, the air pump will continue to collect gas until approximately 10 liters of gas is collected. The flowrate, start time, and end time, must be recorded. If the MVA indicates elevated mercury vapor readings in the breathing zone during field screening, additional air samples will be collected in these areas.

Waste Characterization Sampling

Waste characterization samples will be taken at each of the main transects to gather data to be used in the feasibility study. Samples will be analyzed for synthetic precipitation leaching procedure (SPLP) leachability to calculate the impact to groundwater. Samples will also be analyzed for toxicity characteristics leaching procedure (TCLP) RCRA 8 Metals and Reactivity to use for calculating disposal costs in the feasibility cost estimates.

**QAPP Worksheet #17e: Sampling Design and Rationale
Sediment Sampling (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)**

Associated Field Procedures for these Activities are detailed in:

- Technical SOP 1-2 Sample Custody
- Technical SOP 1-4 Subsurface Soil Sampling
- Technical SOP 1-10 Field Measurement of Total Organic Vapors
- Technical SOP 1-11 Sediment or Sludge Sampling
- Technical SOP 2-1 Packaging and Shipping of Environmental Samples
- Technical SOP 3-1 Geoprobe Sampling
- Appendix C Manuals for Mercury Vapor Analyzers

Associated Field Procedures (continued):

- Technical SOP 4-1 Field Logbook Content and Control
- Technical SOP 4-2 Photographic Documentation of Field Activities
- Technical SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites
- Worksheet 17i Decontamination Procedures
- Worksheet 18 Sampling Locations and Methods/SOP Requirements
- Worksheet 19 Sample Containers, Preservation, and Hold Times
- Worksheet 20 Field Quality Control Summary
- Worksheet 22 Field Equipment Calibration, Maintenance, Testing, and Inspection

QAPP Worksheet #17f: Sampling Design and Rationale
Surface Water Sampling
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

The purpose of the surface water sampling program is to characterize the nature and extent of contamination of surface water within Pierson's Creek and its drainage ditches. The surface water sampling program will be split into two events; one event will be conducted under dry conditions, and the other event will be conducted under wet conditions (during a rainfall event). The dry weather sampling event will provide information on the baseline transport conditions of Pierson's Creek and its drainage ditches, while the wet weather sampling event will provide information on contaminant transport. For the dry weather sampling event, field teams will mobilize after a 48-hour period with less than 0.1-inches of precipitation. For the wet weather sampling event, field teams will mobilize within 8 hours of the start of a 0.5-inch storm preceded by at least a 48-hour period of no precipitation. For each event, surface water samples will be collected from 6-inches below the water surface. The field measurements including pH, temperature, conductivity, DO, redox potential, turbidity, and UVA at 245 nm will be collected prior to sampling.

The sampler should be facing upstream when sampling for proper sample collection and for safety (ability to observe floating objects). Unpreserved sample containers will be dipped directly into water. For analyses that require preservative, the preservative will be added to the bottleware immediately after sample collection, or the sample will be transferred to preserved bottleware. Sample summary and analysis information is provided in **Table 1**.

A total of 27 samples will be collected during both the dry weather and wet weather sampling events. Sample locations are as follows:

Upper Creek Section

A total of six surface water samples will be collected from within the Upper Creek Section (Figure 2) as follows:

- Two surface water samples will be collected within the eastern drainage ditch
- One surface water sample will be collected at each of the two monitoring well transects
- Two surface water samples collected from the section of the creek between the two monitoring well transects

Middle Creek Section

A total of seven surface water samples will be collected from within the Middle Creek Section (Figure 3) as follows:

- One surface water sample in each of the two drainage ditches (eastern and western)
- One surface water sample where the eastern drainage ditch feeds into Pierson's Creek
- One surface water sample at each of the three monitoring well transects
- One surface water sample in the northernmost portion of the Middle Creek Section

QAPP Worksheet #17f: Sampling Design and Rationale
Surface Water Sampling (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Lower Creek Section

A total of eight surface water samples will be collected from within the Lower Creek Section (Figure 4) as follows:

- One surface water sample in each of the three drainage ditches
- One surface water sample where each of the drainage ditches feeds into Pierson's Creek
- Two surface water samples in the culverted section of the Lower Creek Section

Lower Creek Section/Culverted Section

Eight grab samples will be collected from within the culverted section. They are not shown on the sampling figures as access is currently undetermined. ROVs may be necessary to collect samples from the underground portions of Pierson's Creek.

Port Newark Channel

One surface water sample will be collected from the outfall of Pierson's Creek into Port Newark. One surface water sample will also be collected at mid-depth from the Port Newark Channel (Figure 5).

Point and Non-Point Sources

Point and non-point discharges to Pierson's Creek or its drainage ditches identified during the site reconnaissance will be included in the surface water sampling program. Sampling locations and sample analyses will be identified and discussed with EPA prior to conducting sampling of point and non-point discharges. For planning purposes, it is assumed that six point and non-point discharge locations will be identified and sampled during the dry and wet weather sampling.

Associated Field Procedures for these Activities are detailed in:

- Technical SOP 1-1 Surface Water Sampling
- Technical SOP 1-2 Sample Custody
- Technical SOP 2-1 Packaging and Shipping of Environmental Samples
- Technical SOP 4-1 Field Logbook Content and Control
- Technical SOP 4-2 Photographic Documentation of Field Activities
- Technical SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites
- Worksheet 17i Decontamination Procedures
- Worksheet 18 Sampling Locations and Methods/SOP Requirements
- Worksheet 19 Sample Containers, Preservation, and Hold Times

**QAPP Worksheet #17f: Sampling Design and Rationale
Surface Water Sampling (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)**

Associated Field Procedures for these Activities are detailed in (continued):

- Worksheet 20 Field Quality Control Summary
- Worksheet 22 Field Equipment Calibration, Maintenance, Testing, and Inspection

QAPP Worksheet #17g: Sampling Design and Rationale
Soil Sampling
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

The purpose of soil sampling is to characterize the nature and extent of contaminated soil within the Pierson's Creek watershed which can be eroded into the creek and to evaluate whether the solid adjacent to the creek have been impacted by creek overflow. Sample summary and analyses are summarized in **Table 1**.

Prior to starting sampling activities, CDM Smith will visit all sampling locations with a hand-held GPS unit to navigate and mark proposed sampling locations with preset coordinates. Sample locations may be moved based on field observations/conditions. Final sampling location coordinate information will be recorded upon completion. Utilities will be marked for sample locations in the street and locations will be documented via photographs and field notes. If the utility locating service indicates the proposed sampling locations in the street must be moved, CDM Smith will move the location in consultation with EPA.

Each boring will be sampled using a small all-terrain vehicle (ATV) Geoprobe Rig (or equivalent). Soil cores will be collected using 2-inch diameter macro-cores advanced to a total depth of 5 feet bgs. Borings may need to be advanced using hand sampling methods depending on site access. Four samples will be collected from each boring at intervals 0 to 0.5, 0.5 to 1.5, 1.5 to 1, and 3 to 5 feet bgs. The cores will be logged by the onsite geologist for lithology and scanned with a PID and a mercury vapor analyzer.

Upper Creek Section

Three soil borings will be advanced in the Globe Metals property adjacent to the drainage ditch that runs along the eastern border of the Troy Chemical Property (Figure 2).

Middle Creek Section

A total of ten borings will be advanced in the Middle Creek Section as follows (Figure 3):

- Three soil borings will be advanced, one at each of the three monitoring well transects
- Three soil borings will be advanced along the eastern drainage ditch
- One soil boring will be advanced adjacent to the western drainage ditch
- Three soil borings will be advanced in the forested area on the eastern side of Pierson's Creek

The five additional soil borings originally proposed in the forested area on the eastern side of Pierson's Creek were removed from the scope of work because the property owner's consultant, Matrix, will complete adjacent location. CDM Smith will manage the data of these five additional soil borings.

QAPP Worksheet #17g: Sampling Design and Rationale
Soil Sampling (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

Lower Creek Section

A total of nine borings will be advanced in the Lower Creek Section as follows (Figure 4):

- Four soil borings will be advanced, one at each of the four shallow monitoring wells
- Two soil borings will be advanced in the forested area between the eastern drainage ditch and Pierson's Creek
- Three soil borings will be advanced in the forested area on the north border of the long-term airport parking areas.

Associated Field Procedures for these Activities are detailed in:

- Technical SOP 1-2 Sample Custody
- Technical SOP 1-4 Subsurface Soil Sampling
- Technical SOP 1-10 Field Measurement of Total Organic Vapors
- Technical SOP 2-1 Packaging and Shipping of Environmental Samples
- Technical SOP 3-1 Geoprobe Sampling
- Technical SOP 4-1 Field Logbook Content and Control
- Technical SOP 4-2 Photographic Documentation of Field Activities
- Technical SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites
- Worksheet 17i Decontamination Procedures
- Worksheet 18 Sampling Locations and Methods/SOP Requirements
- Worksheet 19 Sample Containers, Preservation, and Hold Times
- Worksheet 20 Field Quality Control Summary
- Worksheet 22 Field Equipment Calibration, Maintenance, Testing, and Inspection

QAPP Worksheet #17h: Sampling Design and Rationale
Groundwater Sampling
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

The purpose of the groundwater investigation is to delineate the impact of groundwater on the nature and extent of contamination within the creek. Two rounds of groundwater samples will be collected from the six existing and 24 new monitoring wells.

Water level and total depth measurements will be collected from each monitoring well using an electronic water level indicator. A submersible Grundfos peristaltic pump (or equivalent) and control box and Teflon-lined polythethylene tubing will be used to sample the monitoring wells using low flow sampling procedures in accordance with SOP 1-12. Groundwater purging will continue until field parameters stabilize according to SOP 1-12, and groundwater purging parameters including pH, ORP, dissolved oxygen (DO), conductivity, and turbidity have stabilized. Upon collection, samples will be packed in coolers and shipped to the laboratory in accordance with SOP 2-1. Groundwater samples summary and analyses are provided in **Table 1**.

Field Procedures for these activities are detailed in:

- SOP 1-2 Sample Custody
- SOP 1-6 Groundwater Level Measurement, Section 5.2 Water Level Measurement Using Electronic Water Level Indicators
- SOP 1-10 Field Measurement of Organic Vapors
- SOP 1-12 Low-Stress (Low-Flow) Groundwater Sampling
- SOP 2-1 Packaging and Shipping of Environmental Samples
- SOP 4-1 Field Logbook Content and Control
- SOP 4-2 Photographic Documentation of Field Activities
- Worksheet 17i Decontamination Procedures
- Worksheet 18 Sampling Locations and Methods/SOP Requirements
- Worksheet 19 Sample Containers, Preservation, and Hold Times
- Worksheet 20 Field Quality Control Summary
- Worksheet 22 Field Equipment Calibration, Maintenance, Testing, and Inspection

QAPP Worksheet #17i: Sampling Design and Rationale
Decontamination Procedures
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

The drilling subcontractor will construct a decontamination pad at the project support area to contain waste soil and water generated from decontaminating equipment. A pump will be used to remove spent decontamination water and will be installed by the subcontractor at the low end of the pad. Off-site movement of steam and water sprays from the decontamination pad will be minimized by erecting a tarpaulin if necessary. Spent decontamination water will be containerized in 55-gallon drums or another suitable container. Field decontamination will be performed on all equipment that enters the exclusion zone. Equipment decontamination procedures will be implemented to prevent cross-contamination of environmental samples and prevent off-site migration of contaminants resulting from site investigation activities. Decontamination procedures to be employed at the Site are summarized below. Refer to SOP 4-5 for a full description of procedures.

The required decontamination procedure for the water level indicator is:

- Wash and scrub with low phosphate detergent*
- Tap water rinse*
- Demonstrated analyte-free water rinse
- Wrap in aluminum foil, shiny side out, for transport

The required decontamination procedure for the submersible pump is:

- Run pump in a 5-gallon bucket of tap water* and low phosphate detergent for at least 5 minutes, scrub outside of the pump while in bucket, and periodically agitate pump with an up and down motion
- Run pump in a 5-gallon bucket of tap water* to rinse for at least 5 minutes
- Run pump in a 5-gallon bucket of demonstrated analyte-free water for at least 5 minutes
- Wrap pump in aluminum foil, shiny side out, for transport

The required decontamination procedure for all sampling equipment is:

- Wash and scrub with low phosphate detergent
- Tap water rinse*
- 10 percent nitric acid rinse (for metals only), laboratory grade
- Isopropanol rinse ** (all solvents must be pesticide-grade or better)
- Demonstrated analyte-free water *** rinse (amount of water must be at least five times that of the solvents used)
- Air dry
- Wrap in aluminum foil, shiny side out, for transport

QAPP Worksheet #17i: Sampling Design and Rationale
Decontamination Procedures (Continued)
(UFP-QAPP Manual Section 3.1.1)
(EPA 2106-G-05 Section 2.3.1)

The required decontamination procedure for heavy equipment is:

- With the rig in place, spray areas (rear of rig) exposed to contaminated media using a hot water high pressure sprayer. Be sure to spray down all surfaces, including the undercarriage.
- Use brushes, soap, and potable water to remove dirt whenever necessary.
- Remove equipment from the decontamination pad and allow it to air dry before returning it to the work site.

The required decontamination procedure for downhole equipment is:

- Place the object to be cleaned on aluminum foil or plastic-covered wooden sawhorses or other supports. The objects to be cleaned shall be at least 2 feet above the ground to avoid splash back when decontaminating.
- Using soap and potable water in the hot water high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.
- If using soapy water, rinse the equipment using clean, potable water. If using hot water, the rinse step is not necessary if the hot water does not contain a detergent. If the hot water contains a detergent, this final clean water rinse is required.
- Using a suitable sprayer, rinse the equipment thoroughly with analyte-free water.
- Remove the equipment from the decontamination area and place in a clean area upwind to air dry.

* Tap water must be from a municipal water treatment system. The use of an untreated potable water supply is not an acceptable substitute.

** Solvent rinse required only when sampling for organics.

*** A sample of the demonstrated analyte-free water will be collected and submitted for chemical analysis. Analytical results will be kept on-site.

While performing decontamination activities, phthalate-free gloves should be used to prevent phthalate contamination of the sampling equipment that could result from the interaction of the gloves with the organic solvents.

Decontamination Equipment

- | | |
|---|--|
| ■ Power source (e.g., generator), if required | ■ Non-phosphate detergent (i.e., Alconox) |
| ■ Distilled/Deionized water | ■ Demonstrated analyte-free water |
| ■ Potable water | ■ Polyethylene sheeting |
| ■ Five-gallon buckets | ■ Personal protective equipment |
| ■ Brush | ■ Air monitoring equipment and calibration gas |
| ■ Aluminum foil | |

**QAPP Worksheet #18: Sampling Locations and Methods
(UFP-QAPP Manual Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.3.1 and 2.3.2)**

See Table 1.

QAPP Worksheet #19 and #30: Sample Containers, Preservation, and Hold Times
(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Laboratory: CLP

List of required accreditations/certifications: CLP (maintained by EPA)

Sample Delivery Method: FedEx Overnight

Analyte/ Analyte Group	Matrix	Analytical and Preparation Method/ SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turn- around Time
VOCs	Sediment/ Soil	SOM02.4	Maintained by EPA	Three 40 milliliter (mL) pre-weighed VOC vials with spin bars	0-6°C	None	Analyze or freeze in 48 hours. Technical - 14 days	42 days
% Moisture – send with VOC vials				One 4-ounce (oz.) jar w/ Teflon lined cap and no headspace	None – no headspace	Technical – 48 hours		42 days
SVOCs				One 8-oz. glass jar Teflon lined cap	0-6°C	14 days	40 days	42 days
Pesticides				One 8 oz. glass jar Teflon lined cap	0-6°C	14 days	40 days	42 days
PCBs				One 8-oz. glass jar Teflon lined cap	0-6°C	14 days	40 days	42 days 42 days
Dioxins/Furans		HRSM01.2		One 8 oz. amber jar w/Teflon lined cap	0-6°C	1 year	None	42 days
TAL Metals		ISM02.4		One 8-oz. glass jar Teflon lined cap	0-6°C	6 months	None	42 days
TAL Cyanide						14 days		
TAL Total Mercury						28 days		

QAPP Worksheet #19 and #30: Sample Containers, Preservation, and Hold Times
(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Laboratory: DESA

List of required accreditations/certifications: NELAP Certified

Sample Delivery Method: FedEx Overnight

Analyte/ Analyte Group	Matrix	Analytical and Preparation Method/ SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turn- around Time
Grain Size	Sediment/ Soil	D6913 and D7928	Maintained by DESA	One 8-oz. glass jar	0-6°C	None		42 days
TOC		Lloyd Kahn		One 8-oz. glass jar	0-6°C	TBD	14 days	42 days
% Solids		ASTM D2216		One 4-oz. jar w/ Teflon lined cap and no headspace	None – no headspace	Technical – 48 hours		42 days

Data package turnaround time includes 21 days for receipt of analytical data and 21 days for data validation completion.

QAPP Worksheet #19 and #30: Sample Containers, Preservation, and Hold Times
(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Laboratory: Subcontract laboratories

List of required accreditations/certifications: NELAP Certified

Sample Delivery Method: FedEx Overnight

Analyte/ Analyte Group	Matrix	Analytical and Preparation Method/ SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turn- around Time
Volatile Mercury	Sediment/ Soil	BAL 3900 or equivalent, Modified	To be provided by subcontract laboratory during procurement	One 4-oz. glass wide mouth jar w/ Teflon lined cap – minimum sample volume 20 grams	Store at 4°C	48 hours	TBD	TBD
Mercury by sequential extraction (Mercury speciation)		BAL 3900 or equivalent with EPA 1631E or equivalent			Cool to 0-4°C on collection - Ship within 48 hours; Laboratory will store at -15°C	14 days	28 days	TBD
Methylmercury		BAL 3200/EPA 1630, Modified		One 4-oz. glass or plastic wide mouth jar	Ice on collection (0- 4°C). Ship within 48 hours;	Store at -15°C within 2 days or no longer than 7 days of collection	6 months for preparation and analysis	42 days
Mercury	Vapor/Air	NIOSH 6009		Solid sorbent tube (hopcalite in single section, 200 mg) (SKC, Inc. Cat. #226-17-1A, or equivalent)	None	30 days at 25°C		TBD

QAPP Worksheet #19 and #30: Sample Containers, Preservation, and Hold Times
(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Laboratory: CLP

List of required accreditations/certifications: CLP (maintained by EPA)

Sample Delivery Method: FedEx Overnight

Analyte/ Analyte Group	Matrix	Analytical and Preparation Method/ SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
VOCs	Aqueous	SOM02.4	Maintained by EPA	Three 40 mL VOA vials with Teflon lined septa	0-6°C HCl to pH<2	7 days unpreserved and 14 days preserved		42 days
SVOCs				Two 1-liter (L) amber glass with polytetrafluoroethylene (PTFE)-lined lid	0-6°C; store in the dark	7 days	40 days	42 days
Pesticides				Two 1 L amber glass with PTFE-lined lid	0-6°C; store in the dark	7 days	40 days	42 days
PCBs				Two 1 L amber glass with PTFE-lined lid	0-6°C; store in the dark	7 days	40 days	42 days
Total and Dissolved TAL Metals and Mercury		ISM02.4		One 1 L high density polyethylene (HDPE)	0-6°C; nitric acid to pH <2	None	6 months/ 28 days	42 days
TAL Cyanide				One 1 L HDPE	NaOH to pH>12; cool to 6°C	TBD	14 days	42 days

QAPP Worksheet #19 and #30: Sample Containers, Preservation, and Hold Times
(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Laboratory: DESA

List of required accreditations/certifications: NELAP Certified

Sample Delivery Method: FedEx Overnight

Analyte/ Analyte Group	Matrix	Analytical and Preparation Method/ SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
TOC	Aqueous	EPA 415.2, 9060 or SM5310B	Maintained by EPA	One 250 mL amber glass bottle	H ₂ SO ₄ to pH <2; Cool 0 to 6°C	N/A	28 days	42 days
POC		EPA 415.1 Modified		One 250 mL amber glass bottle	Filter, H ₂ SO ₄ to pH <2; Cool 0 to 6°C	N/A	28 days	42 days
DOC		EPA 415.1		One 250 mL amber glass bottle	Filter, H ₂ SO ₄ to pH<2; Cool 0 to 6°C	N/A	28 days	42 days
TDS		SM2540C		One 1 L HDPE or amber glass bottle	Cool 0 to 6°C	N/A	7 days	42 days
TSS		SM2540D			Cool 0 to 6°C; No headspace	N/A	28 days	42 days
Chloride, sulfate, phosphate, nitrate		EPA 300		One 250 mL HDPE	Cool 0 to 6°C	N/A	28 days	42 days
Ammonia		EPA 350.1		One 1-L HDPE	Cool 0 to 6°C	N/A	28 days	42 days
Bicarbonate/ Alkalinity		EPA 310.2 or SM2320		One 250-mL HDPE	Cool 0 to 6°C	N/A	28 days	42 days

QAPP Worksheet #19 and #30: Sample Containers, Preservation, and Hold Times
(UFP-QAPP Manual Section 3.1.2.2)
(EPA 2106-G-05 Section 2.3.2)

Laboratory: Subcontract Laboratory

List of required accreditations/certifications: NELAP Certified

List of required accreditations/certifications: Sample Delivery Method: FedEx Overnight

Analyte/ Analyte Group	Matrix	Analytical and Preparation Method/ SOP	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Preparation Holding Time	Analytical Holding Time	Data Package Turnaround Time
Methylmercury	Aqueous	BAL 3200/ EPA 1630 Modified	To be provided by the subcontract laboratory	One 250 mL fluorinated high density polyethylene (FLPE) or glass bottle with FLPE-lined lids	Pre-preserved containers to 0.4% HCl provided; ship immediately at 0 to 6 °C and dark	6 months for preparation and analysis		42 days

QAPP Worksheet #20: Field Quality Control Summary
(UFP-QAPP Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix	Analyte/ Analytical Group	Method/ SOP	Field Samples	Field Duplicates ¹	MS/MSD ¹	Equipment Blanks ¹	Trip Blanks ²	Total
Soil/ Sediment	TCL VOCs	SOM02.4	485	25	25	25	NA	535
	TCL SVOCs	SOM02.4	485	25	25	25	NA	535
	TCL Pesticides	SOM02.4	485	25	25	25	NA	535
	TCL PCBs	SOM02.4	485	25	25	25	NA	535
	TAL Metals, CN, + Hg	ISM02.4	485	25	25	25	NA	535
	Dioxins/furans	HRSM01.2	154	8	8	8	NA	170
	Grain Size	D6913 and D7928	485	25	25	NA	NA	510
	TOC	Lloyd Kahn	485	25	NA	NA	NA	510
	Percent Solids	ASTM D2216	485	25	NA	NA	NA	510
	Volatile mercury	BAL-3900 or equivalent, modified	110	6	6	NA	NA	116
	Methylmercury	BAL-3200/EPA 1630, Modified	485	25	25	NA	NA	510
	6-step mercury by sequential extraction	BAL-3900 or equivalent to EPA 1631E	59	3	3	NA	NA	62

1. MS/MSDs are not required for VOCs and SVOCs for CLP laboratories.

2. It is assumed that one trip blank per cooler per day is necessary.

QAPP Worksheet #20: Field Quality Control Summary
(UFP-QAPP Section 3.1.1 and 3.1.2)
(EPA 2106-G-05 Section 2.2.6)

Matrix	Analyte/ Analytical Group	Method/ SOP	Field Samples	Field Duplicates ¹	MS/MSD ¹	Equipment Blanks ¹	Trip Blanks ²	Total
Waste Characterization (Sediment Sampling)	SPLP Leachability	Modified SW-846, method 1312	5	1	NA	NA	NA	5
	TCLP for RCRA 8 Metals	SW-846, method 1311 and Chapter 7	5	1	NA	NA	NA	5
	Reactivity		5	1	NA	NA	NA	5
Aqueous	TCL VOCs	SOM02.4	134	8	NA	11	11	168
	TCL SVOCs	SOM02.4	134	8	NA	11	NA	153
	TCL Pesticides	SOM02.4	134	8	8	11	NA	161
	TCL PCBs	SOM02.4	134	8	8	11	NA	161
	Total and Dissolved TAL Metals, CN, + Hg - total	ISM02.4	134	8	8	11	NA	161
	Methylmercury	BAL-3200/ EPA 1630 Mod	74	4	4	11	NA	93
	POC	EPA 415.1	134	8	NA	NA	NA	142
	DOC	EPA 415.1	134	8	NA	NA	NA	142
	TDS	SM2540C	134	8	NA	NA	NA	142
	TSS	SM2540D	134	8	NA	NA	NA	142
	Chloride, sulfate, phosphate, nitrate	EPA 300	134	8	NA	NA	NA	142
	Alkalinity/bicarbonate	EPA 310.2	134	8	NA	NA	NA	142
	Ammonia	EPA 350.1	134	8	NA	NA	NA	142

Notes:

1. MS/MSDs are not required for VOCs and SVOCs for CLP laboratories.
2. It is assumed that one trip blank per cooler per day is necessary.
3. TCLP – Toxicity Characteristic Leaching Procedure; RCRA – Resource Conservation and Recovery Act

**QAPP Worksheet #21: Field SOPs
(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)**

SOP # or Reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP Option or Equipment Type (if SOP Provides Different Options)	Modified for Project? Y/N	Comments
1-1	Surface Water Sampling, Rev. 10. February 2015	CDM Smith		N	
1-2	Sample Custody, Rev. 8, February 2015	CDM Smith		N	- Sample tags are not required. - Use Scribe generated chain-of-custody forms (COCs).
1-4	Subsurface Soil Sampling, Rev. 8, February 2015	CDM Smith	DPT rig	N	
1-6	Groundwater Water Level Measurement, Rev. 9, February 2015	CDM Smith	Electrical water level indicators	N	
1-10	Field Measurement of Total Organic Vapor, Rev. 7, February 2015	CDM Smith	PIDs	N	
1-11	Sediment and /or Sludge Sampling, Rev. 10, February 2015	CDM Smith	DPT rig	N	
1-12	Low-Stress (Low-Flow) Groundwater Sampling, Rev. 2, February 2015	CDM Smith	Peristaltic pump	N	
2-1	Packaging and Shipping of Environmental Samples, Rev. 6, February 2015	CDM Smith	SOP Section 1.3 lists materials needed	N	Vermiculite shall not be used.
2-2	Guide to Handling of Investigation-Derived Waste, Rev. 8, February 2015	CDM Smith		N	- All waste will be stored in marked drums - FTL will coordinate handling of waste onsite with field team and drilling subcontractor

**QAPP Worksheet #21: Field SOPs
(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)**

SOP # or Reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP Option or Equipment Type (if SOP Provides Different Options)	Modified for Project? Y/N	Comments
3-1	Geoprobe Sampling, Rev. 7, February 2015	CDM Smith		N	
3-2	Topographic Survey, Rev. 8, February 2015.	CDM Smith		N	
3-5	Lithological Logging, Rev. 9, February 2015	CDM Smith		N	
4-1	Field Logbook Content and Control, Rev. 8, February 2015 ¹	CDM Smith		N	Logbook notes should include decontamination procedures; photograph descriptions; problems encountered; notes of conversations with SM, EPA, subcontractor; and details of samples collected, CLP numbers and visual observations ¹ . Use all lines on a page; any lines that are skipped over or remain at the end of a page should be struck through with a single mark.
4-2	Photographic Documentation of Field Activities, Rev. 9, February 2015	CDM Smith	Camera	N	A note will be added in the logbook that a Photo Log was used.

**QAPP Worksheet #21: Field SOPs
(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)**

SOP # or Reference	Title, Revision, Date, and URL (if available)	Originating Organization	SOP Option or Equipment Type (if SOP Provides Different Options)	Modified for Project? Y/N	Comments
4-3	Well Development and Purging, Rev. 7, February 2015	CDM Smith	SOP Section 5.3 Use YSI 600XL or equivalent water quality meter	N	Water removed during evacuation should not be reintroduced into the well. Record water level in well, pumping flow rate, and the total volume of water purged.
4-4	Design and Installation of Monitoring Wells in Aquifers, Rev. 8, February 2015	CDM Smith		N	
4-5	Field Equipment Decontamination at Nonradioactive Sites, Rev. 10, February 2015	CDM Smith		N	Use phthalate-free gloves.
4-10	Borehole and Well Decommissioning, Rev. 2, February 2015	CDM Smith		N	
SKC, Inc. Publication 1168 Rev 1707	Sampling Train – Single Sorbent Sample Tube	SKC, Inc.	The air will be pumped at a flow rate between 0.15 and 0.25 L/min for 40-60 min to obtain approximately 10 L of air.	N	The sampling train will include an air sample pump capable of sampling at 0.15 to 0.25 L/min, an air flow calibrator (SKC Cat. #375-07550N or equivalent), the sorbent sample tube (SKC Cat. #226-17-1A, or equivalent), and a protective tube cover.

**QAPP Worksheet #21: Field SOPs
(UFP-QAPP Manual Section 3.1.2)
(EPA 2106-G-05 Section 2.3.2)**

¹The following information will be recorded (at a minimum) in the field logbook for each sample collected and shipped:

- Name of field personnel, CDM Smith assigned sample number/location, Date sampled, Date shipped
- Sample location number, Corresponding CLP routine analytical services (RAS) sample number
- Media type, Type of analysis to be performed
- Sample volume and containers, preservatives added to samples
- Any unusual discoloration or evidence of contamination
- Field parameter measurements
- Courier airbill number and means of delivery to the laboratory

²The manuals for operation of the MVA, sorbent tube sampling, and the long-term water level monitoring transducers is provided in Appendix C.

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection
(UFP-QAPP Manual Section 3.1.2.4)
(EPA 2106-G-05 Section 2.3.6)

Field Equipment	Activity	SOP Reference	Responsible Person	Frequency	Acceptance Criteria	Corrective Action
MultiRAE plus PID Toxic Gas Monitor - 11.7 eV lamp	Calibration checked at the beginning and end of day Maintain as needed in field; semi-annually by supplier.	Manufacturer's specifications	FTL	Calibrate am, check pm	± 10% of the calibrated value	Manually zero meter or service as necessary and recalibrate
YSI-600XL or YSI-556MPS Water Quality Meter with Flow Through Cell	Calibrate beginning of day and check calibration at the end of the day. Maintenance performed before shipment and as needed.	Manufacturer's specifications	FTL	Daily, before each use	pH: ± 0.1 DO: ± 0.02 ppm Temp.: ±0.3°C Specific conductivity ±3% ORP: ±0.25% full- scale deflection	Recalibrate or service as necessary
Water Level Meter	Maintenance performed before shipment and as needed.	Manufacturer's specifications	FTL	Check meter daily before each use	Pass/Fail	Return to rental company for replacement
LaMotte Turbidity Meter	Accuracy/calibration check at the beginning and end of the day. Return for replacement.	Manufacturer's specifications	FTL	Calibrate before use and when anomaly suspected	Pass/Fail	Replace battery or bulb or return for replacement

QAPP Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection
(UFP-QAPP Manual Section 3.1.2.4)
(EPA 2106-G-05 Section 2.3.6)

Field Equipment	Activity	SOP Reference	Responsible Person	Frequency	Acceptance Criteria	Corrective Action
Mercury Vapor Analyzer (MVA)*	Change intake fritware	Manufacturer's manual	FTL	Weekly or as needed	If readings are not below 0.05 ug/m ³ change the fritware	Change intake fritware or service as necessary
In-situ vented water level monitoring instrument**	Configure depth and level to water; change desiccant	Manufacturer's manual	FTL	Before installation in well; as needed	Depth and water level match historical readings; if desiccant turns pink replace desiccant	Reconfigure depth or service as necessary
SKC AirChek® Series with All-in-One Low Flow Adapter/Holde	Connect the open end of the sorbent tube to an external calibrator (TSI 4146 Calibrator Cat. # 740-4146) and set flow rate in desired range.	Manufacturer's manual	FTL	Each sample	Pass/Fail	Service as necessary

*Mercury vapor analyzer will be a Jerome J505 or equivalent. The operation manual is provided in Appendix C.

**In-situ vented water level monitoring instrument will be a TROLL 500 or equivalent. The specification sheet and manual are provided in Appendix C.

QAPP Worksheet #23: Analytical SOPS
(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or	Modified for Project?
				Equipment Type	Y/N
SOM02.4	<i>EPA CLP SOW for Organic Superfund Methods Multi-Media, Multi-Concentration, SOM02.4.</i> EPA October 2016 https://www.epa.gov/clp/epa-contract-laboratory-program-statement-work-organic-superfund-methods-multi-media-multi-1	Definitive	Aqueous & Soil/Sediment-VOC, SVOC, Pesticides, PCBs, moisture content	Gas chromatograph/mass spectroscopy (GC/MS) GC/electron capture detector (ECD); FID	N
ISM02.4	<i>EPA CLP SOW for Inorganic Superfund Methods Multi-Media, Multi-Concentration.</i> EPA October 2016. https://www.epa.gov/clp/epa-contract-laboratory-program-statement-work-inorganic-superfund-methods-multi-media-multi-1		Aqueous & Soil/Sediment-TAL Metals, CN + Hg	ICP-AES/ICP-MS, Colorimeter, CVAA	N
HRSM01.2	<i>EPA CLP SOW for High Resolution Superfund Methods Multi-Media, Multi-Concentration.</i> EPA October 2014. https://www.epa.gov/clp/epa-contract-laboratory-program-statement-work-high-resolution-superfund-methods-multi-media		Aqueous & Soil/Sediment-Dioxins/Furans	HRGC/HRMS	N
BAL-3200 based on EPA 1630/	<i>Determination of Methyl Mercury by Aqueous Phase Ethylation, Trap Pre-Collection, Isothermal GC Separation and CVAFS Detection.</i> Revised 7/7/17. Draft Methylmercury Using Distillation, Aqueous Methylation, Purge and Trap, and Cold Vapor Atomic Fluorescence. July 27, 2010. (EPA 1630 Modified)		Aqueous & Soil/Sediment-Methylmercury	Cold vapor atomic fluorescence spectrometry (CVAFS)	N
BAL-3900	<i>Six-Step Selective Sequential Extraction (SSE) Procedure to Quantify Mercury Fractions in Sediment, Soils, and Other Solids</i> (Mercury Speciation). Brooks Applied Laboratory. Rev. 001. October 2016.		Soil/Sediment-Mercury speciation and total mercury	TBD	N
BAL-3900	Volatile Elemental Mercury (to be provided by subcontract laboratory upon procurement)		Soil Sediment-Volatile elemental mercury	TBD	Y
EPA 415.1	Modified: "Standard Operating Procedure: Total Organic Carbon - Sediment." Revision 2.1. January 31, 2009.		Aqueous – POC, DOC	Filter and carbon analyzer with IR or FID	N

QAPP Worksheet #23: Analytical SOPs
(UFP-QAPP Manual Section 3.2.1)
(EPA 2106-G-05 Section 2.3.4)

SOP #	Title, Date, and URL (if available)	Definitive or Screening Data	Matrix/Analytical Group	SOP Option or	Modified for Project?
				Equipment Type	Y/N
SM2540C	Standard Methods. Modified: "Standard Operating Procedure: Total Dissolved Solids." Revision 2.1. January 2009.	Definitive	Aqueous - TDS	Gravimetric	N
SM2540D	Standard Operating Procedure: Total Suspended Solids Volatile Suspended Solids." Revision 3.1. January 31, 2009.		Aqueous -TSS	Filter, oven, balance	N
EPA 300	Determination of Inorganic Anions by Ion Chromatography.		Aqueous – Chloride, sulfate, phosphate, nitrate	Ion chromatography	N
EPA 350.1	MCAWW. Revised 1983		Aqueous - Ammonia	Colorimeter - automated	N
EPA 310.2	MCAWW. Revised 1983		Aqueous – Bicarbonate/Alkalinity	Colorimeter	N
EPA 1311	EPA SPLP. https://www.epa.gov/sites/production/files/2015-12/documents/1312.pdf		SPLP Leachability	TBD	Y
EPA 1312	EPA TCLP. https://www.epa.gov/sites/production/files/2015-12/documents/1311.pdf		TCLP RCRA 8 Metals	TBD	N
NIOSH 6009	Mercury 6009, NIOSH Manual of Analytical Methods, Fourth Edition, 1994. https://www.cdc.gov/niosh/docs/2003-154/pdfs/6009.pdf		Mercury	AES with cold vapor generation system or cold vapor mercury analysis system	N

1. EPA reviews CLP laboratories SOPs. DESA laboratory SOPs will apply for grain size, TOC, POC, DOC, % solids, TSS, TDS, and water quality parameters. FASTAC policy will be implemented for procuring laboratory services. A subcontract laboratory will be necessary to complete the analyses of methylmercury, mercury by speciation, and volatile elemental mercury. At the time of this QAPP, the subcontract laboratory is still being procured.

2. For non- RAS data, the ASC will submit the "Analytical Services Tracking System (ANSETS) Data Requirement" form to the RSCC by the first day of each month for the previous month's sampling.

QAPP Worksheet #24: Analytical Instrument Calibration
(UFP-QAPP Manual Section 3.2.2)
(EPA 2106-G-05 Section 2.3.6)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	SOP Reference
HRGC/HRMS and HRGC/low resolution mass spectrometry	Initial calibration and calibration verification check: Per laboratory SOP	After set up, prior to run, and after instrument changes or failures of checks	Percent RSD and %R per laboratory SOPs.	Check, correct; re-calibrate and rerun all samples analyzed after last valid calibration check.	Laboratory analyst/QA officer - TBD	TBD
	Calibration checks: CCVs per laboratory SOP	Daily: Beginning of run and after every 10 samples and at end of analytical run	%R per laboratory SOP.	Check, correct; re-calibrate and rerun all samples analyzed after last valid calibration check.	Laboratory analyst/QA officer - TBD	
GC/MS; GC; GC/FID	Initial calibration: 5 points standards	Upon award of the contract, whenever the laboratory takes corrective action that may change or affect the initial calibration criteria (e.g., ion source cleaning or repair, column replacement), or if the continuing calibration acceptance criteria have not been met	Relative response factor (RRF) \geq minimum acceptable RRF listed in Table 5 of procedure. All target compounds, initial RSD \leq 10 percent or 20 percent and correlation coefficient (r) > 0.995 . %RSD \leq value in Table 5 of SOM01.2 or per laboratory SOP as applicable.	Inspect system for problems (e.g., clean ion source, change the column, service the purge and trap device), correct problem, re-calibrate.	Laboratory technician	TBD
GC/MS	Calibration standards verification	Each lot of standards	As per laboratory established control limits.	Inspect system; correct problem; re-run standard and affected samples.	Laboratory GC/MS technician	TBD
GC/MS	Tuning	Daily: Every 12 hours	RFs and RRF as method specified	Inspect system; correct problem; re-run standard and affected samples.	Laboratory GC/MS technician	

QAPP Worksheet #24: Analytical Instrument Calibration
(UFP-QAPP Manual Section 3.2.2)
(EPA 2106-G-05 Section 2.3.6)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	SOP Reference
GC/FID	Mass discrimination check	Every 12 hours	RF ratio of C32/C20 should be >0.8	Per laboratory SOP.	Laboratory GC/FID technician	TBD
CV-GAS	Calibration; 3-point standards	After instrument set up	$R^3 \geq 0.995$	Inspect system; correct problem.	Laboratory technician	TBD
	ICV	Before sample analysis	80-120%R; source of standard separate from calibration standards	Do not analyze samples until problem is corrected.		
	CCV	10 percent or every 2 hours, whichever is more frequent	80-120%R	Inspect system, re-calibrate and rerun associated samples.		
AA -CV – elemental Hg analysis	Calibration - 2 series of 6 standards	Beginning and end of analytical run	Per laboratory SOP	Inspect system, re-calibrate and rerun associated samples.	Laboratory Analyst	TBD
	Intermediate standards for calibration verification	Intermediately with samples				
ICP-MS/AES ISM02.4	See ISM02.4/ per instrument manufacturer's procedures	Initial calibration: Daily or once every 24 hours and each time the instrument is set up	ICP-MS: As per instrument manufacturer's procedures, at least 2 standards	Inspect the system, correct problem, re-calibrate, and re-analyze samples.	Laboratory ICP-AES/ICP-MS technician or DESA laboratory analyst/QA office	TBD
	Initial calibration	Daily; after tuning and optimizing instrument	Correlation coefficient >0.995 with a minimum of 3 standards and a blank	Repeat analysis; re-prepare calibration standards and reanalyze.		
	ICV	Before sample analysis	90-110%R; source of standard separate from calibration standards	Re-calibrate instrument; prepare fresh ICV standards; do not analyze samples until problem is corrected.		

QAPP Worksheet #24: Analytical Instrument Calibration
(UFP-QAPP Manual Section 3.2.2)
(EPA 2106-G-05 Section 2.3.6)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	SOP Reference
	Reporting limit standard	After initial calibration verification standard	80-120%R or concentration ≤ 30 percent difference (from true value)	Re-analyze failed standard.		
	CCV	Every 10 samples and at end of analytical sequence	90-110%R; source of standard separate from calibration standards	Re-check; re-calibrate and rerun all samples analyzed after last valid CCV.		
Soil TOC Analyzer	Calibration and corrective action as per Manufacturer's instruction. No samples shall be analyzed if instrument calibration exceeds the acceptance criteria.				Laboratory analyst / QA Officer TBD	TBD
Colorimeter	Initial Calibration; 4 to 9 point standards	Every 3 months or as per laboratory SOP	90-110%R	Re-check; re-calibrate.	Laboratory analyst/QA officer - TBD	TBD
	Calibration check	Every 10 samples and at end of analytical run	80-120%R	Re-check; re-calibrate and rerun all samples analyzed after last valid calibration check.		
Thermometer	Calibration	Quarterly; serviced annually	$\pm 1^{\circ}\text{C}$ of true value of National Institute of Standards and Technology traceable thermometer	Replace defective thermometer.		
pH meter	Daily buffer checks (2-point bracketing sample pH)	Before use/per batch; or as per rental company /manufacturer's recommendations	± 0.1 pH units or ± 0.05 pH units	Recheck; replace buffer solutions. If still fails, fix instrument or put out of service.	Laboratory analyst/QA officer - TBD	TBD

Notes:

- The FASTAC decision process will be used for procuring laboratory services. CLP and DESA, laboratory calibration and/or method SOPs will be utilized to meet calibration criteria. Specific instrument information (Manufacturer and model) is not available at this time.
- TBD - Reference SOP depends on the laboratory assignment. EPA maintains CLP laboratory SOP information. CDM Smith will submit the subcontract laboratory's SOP.
- R represents the correlation coefficient.
- The laboratory SOP will include the calibration range information.
- NJDEP <http://www.nj.gov/dep/srp/guidance/fspm/pdf/chapter06e.pdf>.
- The cover pages for the complex mercury analyses SOPs are presented in Appendix D.

QAPP Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing, and Inspection
(UFP-QAPP Manual Section 3.2.3)
(EPA 2106-G-05 Section 2.3.6)

Instrument/ Equipment	Maintenance Activity	Testing Activity Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Title/Position Responsible for Corrective Action	Reference
Analytical instrument maintenance, testing and inspection information, and availability of spare parts are not available since the FASTAC decision process will be utilized for analytical services. If CDM Smith subcontract laboratories are used, information is provided in their QA manuals. Maintenance, testing, and inspection frequencies are documented in the Master Services Agreement (MSA) laboratories' SOPs.							

QAPP Worksheet #26 and 27: Sample Handling, Custody, and Disposal
(UFP-QAPP Manual Section 3.3)
(EPA 2106-G-05 Section 2.3.3)

Sampling Organization: CDM Smith

Laboratory: DESA, CLP, subcontract laboratory for complex mercury analyses (TBD)

Method of sample delivery (shipper/carrier): FedEx

Number of days from reporting until sample disposal: DESA 30 days or CLP as per contract or subcontract laboratory 60-90 days as specified in SOW

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP reference
Sample labeling	CDM Smith – FTL	Technical SOP 2-1
Chain-of-custody form completion	CDM Smith – FTL	Technical SOP 1-2
Packaging	CDM Smith – FTL	Technical SOP 1-2 and 2-1; EPA CLP guidance for field samplers
Shipping coordination	CDM Smith – FTL, CDM Smith ASC	Technical SOP 2-1
Sample receipt, inspection, and log-in	Laboratory custodian (DESA, CLP, or subcontract)	Analytical scope of work and laboratory SOP
Sample custody and storage	CDM Smith and laboratories (DESA, CLP, or subcontract)	Technical SOP 1-2; analytical SOW or laboratory Technical SOP
Sample disposal	Laboratory custodian (DESA, CLP, or subcontract)	Laboratory Technical SOP

Notes:

Trip blanks will be identified using the abbreviation TB followed by the date. For example, TB-070108 indicates the trip blank was collected on July 1, 2008.

**QAPP Worksheet #28a: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)**

Matrix Aqueous
Analytical Group TCL VOCs Trace or Low (µg/L)
Analytical Method/SOP Reference SOM02.4

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Field Duplicates	1 per 20 samples	None		Notify SM and flag duplicate results.	CDM Smith ASC and FTL	≤40%RPD when both samples ≥5x CRQL otherwise* ABS ≤ 2xCRQL	
Temperature Blank	1 per cooler	0 to 6°C		Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant	Laboratory Analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6 degrees C	
Trip Blank	1 per cooler	≤ CRQL		Verify results; re-analyze. Flag outliers.	Laboratory analyst	≤ CRQL	
Method Blank	1 every 12 hours	No analyte > CRQL*		Suspend analysis unit source recertified.	DESA or EPA CLP Laboratory GC/MS Technician	No analyte > CRQL*	
Deuterated Monitoring Compounds	all samples	Vinyl chloride-d3	40-130%R	Check calculations and instruments, reanalyze affected samples.		Vinyl chloride-d3	40-130%R
		Chloroethane-d5	65-130%R			Chloroethane-d5	65-130%R

*Except for methylene chloride, 2-butanone and acetone, which can be up to 2 times the CRQL.

**QAPP Worksheet #28a: Analytical Quality Control and Corrective Action
(Aqueous TCL VOCs continued)**

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
TCL Low VOCs Continued							
Deuterated Monitoring Compounds [cont'd]	all samples	1,1-Dichloroethene-d2	60-125%R	Check calculations and instruments, reanalyze affected samples; up to 3 DMCs per sample may fail to meet recovery limits	DESA or EPA CLP laboratory GC/MS technician	1,1-Dichloroethene-d2	60-125%R
		2-Butanone-d5	40-130%R			2-Butanone-d5	40-130%R
		Chloroform-d	70-125%R			Chloroform-d	70-125%R
		1,2-Dichloroethane-d4	70-130%R			1,2-Dichloroethane-d4	70-130%R
		Benzene-d6	70-125%R			Benzene-d6	70-125%R
		1,2-Dichloropropane-d6	60-140%R			1,2-Dichloropropane-d6	60-140%R
		Toluene-d8	70-130%R			Toluene-d8	70-130%R
		trans-1,3-Dichloropropene-d4	55-130%R			trans-1,3-Dichloropropene-d4	55-130%R
		2-Hexanone-d5	45-130%R			2-Hexanone-d5	45-130%R
		1,1,2,2-Tetrachloroethane-d2	60-125%R			1,1,2,2-Tetrachloroethane-d2	60-125%R
		1,2-Dichlorobenzene-d4	80-120%R			1,2-Dichlorobenzene-d4	80-120%R
Internal Standards	all samples	60-140 percent		Check calculations and instruments, reanalyze affected samples		± 40 percent of response area, ± 20 sec retention time shift	

**QAPP Worksheet #28a: Analytical Quality Control and Corrective Action
(Aqueous TCL VOCs continued)**

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Matrix Spike/ Matrix Spike (Not Required for CLP) Accuracy	1 per 20 samples or less (if requested)	1,1-Dichloroethene	61-145%R	Flag outliers	DESA/ CLP Laboratory GC/MS Technician	1,1-Dichloroethene	61-145%R
		Trichloroethene	71-120%R			Trichloroethene	71-120%R
		Benzene	71-127%R			Benzene	71-127%R
		Toluene	76-125%R			Toluene	76-125%R
		Chlorobenzene	75-130%R			Chlorobenzene	75-130%R
Matrix Spike Duplicate (Not Required for CLP) Precision	1 per 20 samples or less (if requested)	1,1-Dichloroethene	0-14%RPD	Flag outliers		1,1-Dichloroethene	0-14%RPD
		Trichloroethene	0-14%RPD			Trichloroethene	0-14%RPD
		Benzene	0-11%RPD			Benzene	0-11%RPD
		Toluene	0-13%RPD			Toluene	0-13%RPD
		Chlorobenzene	0-13%RPD			Chlorobenzene	0-13%RPD

QAPP Worksheet #28b: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Aqueous
Analytical Group TCL SVOCs
Analytical Method/SOP Reference SOM02.4

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Notify SMan and flag duplicate results.	CDM Smith ASC and SM	$\leq 40\%$ RPD when both results $\geq 5 \times \text{CRQL}$ otherwise $\text{ABS} \leq 2 \times \text{CRQL}$
Temperature Blank	1 per cooler	0 to 6° C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6 degrees C
Method Blank	1 per ≤ 20 samples or batch	No analyte > CRQL*	Stop analysis, re-extract and reanalyze affected samples.	DESA or CLP laboratory GC/MS technician	$\leq \text{CRQL}$

*Except for bis (2-Ethylhexyl) phthalate, which can be up to 5 times the CRQL. (EPA CLP National Functional Guidelines)

**QAPP Worksheet #28b: Analytical Quality Control and Corrective Action
(Aqueous TCL SVOCs Continued)**

Laboratory QC Sample	Frequency / Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
TCL SVOCs [cont'd]						
Deuterated Monitoring Compounds (DMCs)	all samples	1,4-Dioxane-d8	40-110%R	Check calculations and instruments, reanalyze affected samples; up to 4 DMCs may fail to meet recovery limits.	DESA or CLP laboratory GC/MS technician	Same as method acceptance limits
		Phenol-d5	10-130%R			
		Bis(2-chloroethyl)ether-d8	25-120%R			
		2-Chlorophenol-d4	20-130%R			
		4-Methylphenol-d8	25-125%R			
		4-Chloroaniline-d4	1-146%R (advisory)			
		Nitrobenzene-d5	20-125%R			
		2-Nitrophenol-d4	20-130%R			
		2,4-Dichlorophenol-d3	20-120%R			
		Dimethylphthalate-d6	25-130%R			
		Acenaphthylene-d8	10-130%R			
		4-Nitrophenol-d4	10-150%R			
		Fluorene-d10	25-125%R			
		4,6-Dinitro-2-methylphenol-d2	10-130%R			
		Anthracene-d10	25-130%R			
		Pyrene-d10	15-130%R			
		Benzo(a)pyrene-d12	20-130%R			
		Fluoranthene-d10 (SIM)	30-130%R			
		2-Methylnaphthalate-d10 (SIM)	30-130%R			
		simultaneous ion monitoring [SIM])				
Internal Standards	all samples	50-100 percent of area, ± 20 second retention time shift		Check calculations /instruments. Re-analyze affected samples.	DESA or CLP laboratory GC/MS technician	50-100 percent of area, ± 20 second retention time shift

**QAPP Worksheet #28b: Analytical Quality Control and Corrective Action
(Aqueous TCL SVOCs continued)**

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Matrix Spike/Matrix Spike Duplicate (Not Required for CLP) Accuracy	1 per 20 samples or less (if requested)	Phenol	12-110%R	Flag outliers	DESA/ CLP laboratory GC/MS technician	Same as Method QC Limits
		2-Chlorophenol	27-123%R			
		N-Nitroso-di-n-propylamine	41-116%R			
		4-Chloro-3-methylphenol	23-97%R			
		Acenaphthene	46-118%R			
		4-Nitrophenol	29-94%R			
		2,4-Dinitrotoluene	24-96%R			
		Pentachlorophenol	9-103%R			
		Pyrene	26-127%R			
Matrix Spike/Matrix Spike Duplicate (Not Required for CLP) Precision	1 per 20 samples or less (if requested)	Phenol	0-42%RPD	Flag outliers	DESA/ CLP laboratory GC/MS technician	Same as Method QC Limits
		2-Chlorophenol	0-40%RPD			
		N-Nitroso-di-n-propylamine	0-38%RPD			
		4-Chloro-3-methylphenol	0-42%RPD			
		Acenaphthene	0-31%RPD			
		4-Nitrophenol	0-50%RPD			
		2,4-Dinitrotoluene	0-38%RPD			
		Pentachlorophenol	0-50%RPD			
		Pyrene	0-31%RPD			

QAPP Worksheet #28c: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Aqueous
Analytical Group TCL Pesticides
Analytical Method/SOP Reference SOM02.4

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Field Duplicates	1 per 20 samples	None		Notify SM and flag duplicate results.	CDM Smith ASC and SM	≤40%RPD when PCBs in both samples ≥ 5xCRQL Otherwise ABS ≤ 2xQL	
Temperature Blank	1 per cooler	0 to 6°C		Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6 degrees C	
Method Blank	1 per ≤20 samples or whenever samples extracted	No analyte > CRQL		Suspend analysis –re-extract and reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	No analyte > CRQL No target analyte concentrations ≥ ½ CRQL	
Matrix Spike	1 per ≤20 samples; if requested	Gamma-BHC (lindane)	56-123%R	Flag outliers.	DESA or CLP laboratory GC/ECD technician	Gamma-BHC	56-123%R
		Heptachlor	40-131%R			Heptachlor	40-131%R
		Aldrin	40-20%R			Aldrin	40-120%R
		Dieldrin	52-126%R			Dieldrin	52-126%R
		Endrin	56-121%R			Endrin	56-121%R
		4,4'-DDT	38-127%R			4,4'-DDT	38-127%R

**QAPP Worksheet #28c: Analytical Quality Control and Corrective Action
(Aqueous TCL Pesticides continued)**

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Matrix Spike Duplicate	1 per ≤20 samples; if requested	Gamma-BHC (Lindane)	0-15%RPD	Flag outliers.	DESA or CLP laboratory GC/ECD technician	Gamma-BHC	0-15%RPD
		Heptachlor	0-20%RPD			Heptachlor	0-20%RPD
		Aldrin	0-22%RPD			Aldrin	0-22%RPD
		Dieldrin	0-18%RPD			Dieldrin	0-18%RPD
		Endrin	0-21%RPD			Endrin	0-21%RPD
		4,4'-DDT	0-27%RPD			4,4'-DDT	0-27%RPD
LCS	1 per ≤20 samples	Heptachlor epoxide	50-150%R	Check calculations and instruments; reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	Heptachlor epoxide	50-150%R
		Dieldrin	30-130%R			Dieldrin	30-130%R
		Gamma-BHC	50-120%R			Gamma-BHC	50-120%R
		4,4'-DDE	50-150%R			4,4'-DDE	50-150%R
		Endrin	50-120%R			Endrin	50-120%R
		Endrin sulfate	50-120%R			Endrin sulfate	50-120%R
Surrogate	all samples	Gamma-Chlordane	30-130%R	Check calculations and instruments; reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	Gamma-Chlordane	30-130%R

QAPP Worksheet #28d: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Aqueous
Analytical Group TCL PCBs/Aroclors
Analytical Method/SOP Reference SOM02.4

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Field Duplicates	1 per 20 samples	None		Notify SM and flag duplicate results.	CDM Smith ASC and SM	≤40%RPD when PCBs in both samples ≥ 5xCRQL Otherwise ABS ≤ 2xQL	
Temperature Blank	1 per cooler	0 to 6°C		Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6 degrees C	
Method Blank	1 per ≤20 samples or whenever samples extracted	No analyte > CRQL		Suspend analysis –re-extract and reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	No analyte > CRQL No target analyte concentrations ≥ ½ CRQL	
Matrix Spike	1 per ≤20 samples; if requested	Aroclor-1016	29-135%R	Flag outliers.	DESA or CLP laboratory GC/ECD technician	Aroclor-1016	29-135%R
		Aroclor-1260	29-135%R			Aroclor-1260	29-135%R
Matrix Spike Duplicate		Aroclor-1016	0-15%RPD			Aroclor-1016	0-15%RPD
		Aroclor-1260	0-20%RPD			Aroclor-1260	0-20%RPD
LCS	1 per ≤20 samples	Aroclor-1016	50-150%R	Check calculations and instruments; reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	Aroclor-1016	50-150%R
		Aroclor-1260	50-150%R			Aroclor-1260	50-150%R
Surrogate	all samples	30-150%R		Check calculations and instruments; reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	30-150%R	

**QAPP Worksheet #28e: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)**

Matrix Aqueous
Analytical Group TAL Metals ICP MS/AES (Total and dissolved)
Analytical Method/SOP Reference ISM02.4

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Notify SM and flag duplicate results.	CDM Smith ASC and SM	$\leq 40\%$ RPD when both results $\geq 5 \times$ CRQL, ABS $\leq 2 \times$ CRQL when any result $\leq 5 \times$ CRQL
Temperature Blank	1 per cooler	0 to 6°C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data > 6 degrees C
Preparation Blank	1 per ≤ 20 samples	No constituent > CRQL	Suspend analysis rectify source; redigest and reanalyze affected samples.	DESA or CLP laboratory ICP technician	No constituent > CRQL
Spike	1 per ≤ 20 samples	75-125%R*	Flag outliers.		75-125%R*
Laboratory Duplicate	1 per ≤ 20 samples	$\pm 20\%$ RPD**	Flag outliers.		$\leq 20\%$ RPD**
Post-Digestion Spike	after any analyte (except Ag) fails spike %R	75-125%R	Flag outliers.		75-125%R
Interference Check Sample [ICP Analysis Only]	Beginning of each run	\pm CRQL + true value or ± 20 percent of true value, whichever is greater	Check calculations and instruments; reanalyze affected samples.	DESA or CLP laboratory ICP technician	± 2 times CRQL of true value or ± 20 percent of true value, whichever is greater
LCS	1 per ≤ 20 samples	70-130%R	Suspend analysis until source rectified; re-digest and reanalyze affected samples.	DESA or CLP laboratory ICP technician	70-130%R

*Except when the sample concentration is greater than 4 times the spike concentration, then disregard the recoveries; no data validation action taken.

** Except when the sample and/or duplicate concentration is less than 5 times the CRQL, then \pm CRQL.

QAPP Worksheet #28f: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix

Aqueous

Analytical Group

TAL – Total Cyanide – Spectrophotometer (Total and dissolved)

Analytical Method/SOP Reference

ISM02.4

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Notify SM and flag duplicate results.	CDM Smith ASC and SM	≤40%RPD when both results ≥ 5xCRQL, ABS ≤ 2xCRQL when either result ≤ 5xCRQL
Temperature Blank	1 per cooler	0 to 6°C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6 degrees C
Equipment blank	1 per decontamination event not to exceed 1 per day	≤ CRQL	Verify results; re-analyze. Flag outliers. Check decontamination procedures.	Laboratory analyst and CDM Smith FTL	≤ CRQL
Preparation Blank (PB)	1 per ≤20 samples	No analyte > CRQL	Suspend analysis; re-digest and reanalyze.	DESA or CLP laboratory technician	No analyte > CRQL
Laboratory Duplicate	1 per ≤20 samples	± 20%RPD*	Flag outliers.	DESA or CLP laboratory technician	≤ 20%RPD
Spike Sample	1 per ≤20 samples	75-125- %R	Flag outliers.	DESA or CLP laboratory technician	75-125%R

*Reference EPA Region 2 SOP No. HW-2c, Revision 15 - (include ABS criteria)

QAPP Worksheet #28g: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix

Aqueous

Analytical Group

TAL – Total Mercury CVAA (Total and dissolved)

Analytical Method/SOP Reference

ISM02.4

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Notify SM and flag duplicate results.	CDM Smith ASC and SM	≤40%RPD when both results ≥ 5xCRQL, ABS ≤ 2xCRQL when either result ≤ 5xCRQL
Temperature Blank	1 per cooler	0 to 6°C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6° C
Equipment blank	1 per decontamination event not to exceed 1 per day	≤ CRQL	Verify results; re-analyze. Flag outliers. Check decontamination procedures.	Laboratory analyst and CDM Smith FTL	≤ CRQL
Preparation Blank (PB)	1 per ≤20 samples	No analyte > CRQL	Suspend analysis; re-digest and reanalyze.	DESA or CLP laboratory technician	No analyte > CRQL
Laboratory Duplicate	1 per ≤20 samples	± 20%RPD*	Flag outliers.	DESA or CLP laboratory technician	≤ 20%RPD
Spike Sample	1 per ≤20 samples	75-125- %R	Flag outliers.	DESA or CLP laboratory technician	75-125%R

*Reference EPA Region 2 SOP No. HW-2c, Revision 15 - (include ABS criteria)

**QAPP Worksheet #28h: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)**

Matrix Aqueous
Analytical Group Methylmercury-Trace
Analytical Method/SOP Reference BAL-3200/EPA 1630 Modified

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	RPD <35%	Data assessor to inform SM if MPC is exceeded; address in DQA	CDM Smith ASC/ Laboratory Analyst	≤40%RPD when both results ≥ 5xCRQL otherwise ABS ≤ 2xCRQL
Temperature Blank	1 per cooler	0 to 6 degrees C	Note in laboratory narrative. CDM Smith will use more coolant; check packing procedure	Laboratory Analyst	≤ 6 degrees C
Preparation Blank	1 per 20 samples or batch	< 0.0001 ng/L per laboratory SOP	Suspend analysis until source rectified; re-distill and reanalyze affected samples if results are <10 times the blank	Laboratory Analyst	No result > QL
LCS	1 per 20 samples batch or per day	Per limits in LIMS	Stop analysis and recalibrate or report data with an appropriate qualifier. Document on CAR form.	Laboratory Analyst	Per limits in LIMS
Quality Control Sample	1 per 20 samples batch or 1 per day mid batch	Per laboratory SOP – or method Table 2	Investigate and correct; Flag outliers; Note in case narrative. Multiple failures require re-distillation and reanalysis.	Laboratory Analyst	Per laboratory SOP
Initial and Ongoing Precision and Recovery (IPR/OPR) Samples	1 per 20 samples or group of field samples at end of run or 12-hour shift	Per laboratory SOP	Check calculations and instruments, recalibrate for IPR and reanalyze affected samples for OPR	Laboratory Analyst	77-123%R of true value for OPR 79-121%R for IPR per method
MS/MSD	1 per 20 samples or with each group of field samples	Per limits in LIMS	Investigate matrix effects and note in data narrative	Laboratory Analyst	75-125%R
					RPD ≤25%

ng/L – nanogram per liter

LIMS – laboratory information management system

QAPP Worksheet #28i: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Aqueous
Analytical Group TOC
Analytical Method/SOP Reference EPA 415.2, 9060 or SM5310B

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Data assessor to inform SM and flag duplicate results if MPC is exceeded.	CDM Smith ASC and SM	$\leq 40\% \text{RPD}$, $\text{ABS} \leq 2 \times \text{CRQL}$ when any result $\leq 5 \times \text{CRQL}$
Temperature Blank	1 per cooler	0 to 6°C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C Validator will apply professional judgment in qualifying data > 6° C
Matrix Spike	1 per ≤ 20 samples	75-125%R*	Flag outliers.	DESA or CLP laboratory ICP technician	75-125%R*
Laboratory Duplicate	One per batch	$\pm 20\% \text{RPD}^{**}$	Flag outliers.		$\leq 40\% \text{RPD}^{**}$
Method Blank	1 per 20 samples	< QL	If samples are non-detect or if lowest sample result is >10 times the blank, no action; otherwise redigest and reanalyze.		No analyte > QL
LCS	1 per ≤ 20 samples	80-120%	Suspend analysis until source rectified; re-digest and reanalyze affected samples.		80-120%

*Except when the sample concentration is greater than 4 times the spike concentration, then disregard the recoveries; no data validation action taken.

** Except when the sample and/or duplicate concentration is less than 5 times the CRQL, then $\pm \text{CRQL}$.

QAPP Worksheet #28j: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix

Aqueous

Analytical Group

Wet Chemistry-DOC/POC

Analytical Method/SOP Reference

EPA Method 415.1¹

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Method Blank /Calibration Blank	1 per batch of 20 samples or less	< QL	If samples non-detect or if lowest sample result is >10 times the blank, no action; otherwise redigest and reanalyze. Flag results or modify reporting limit.	DESA Analyst	No analyte > QL
Laboratory Duplicate	1 per batch of 20 samples or less	Per DESA SOP	Flag outliers	DESA Analyst	RPD \leq 20 if values >5xQL otherwise ABS \leq 2xQL
LCS/ QC sample	1 per batch of 20 samples or less	80-120%R	Identify source of problem, re-prepare and re-analyze or flag outliers	DESA Analyst	80-120%R
Field Duplicate	1 per 20 samples per event	None	Data assessor to inform SM if MPC is exceeded; flag results in report	DESA Analyst / CDM Smith FTL	RPD \leq 40% if results >5xQL otherwise ABS \leq 2xQL
Temperature Blank	1 per cooler	0 to 6 degrees C	Note outlier in laboratory narrative. Inform CDM Smith of failure and need for additional coolant; check packing procedure	CDM Smith FTL	\leq 10 degrees C for data validation

1. QAPP Worksheet # 23 provides more information on the sampling and analytical SOPs.

Matrix	Aqueous
Analytical Group	Wet Chemistry - TSS
Analytical Method/SOP Reference	SM2540D



QAPP Worksheet #28I: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix

Aqueous

Analytical Group

Wet Chemistry –TDS

Analytical Method/SOP Reference

SM2540C

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Preparation/ Method Blank	1 per batch of 20 samples	None	If results are non-detect or if lowest sample result is >10 times the blank, no action; otherwise reanalyze and qualify data	DESA Analyst	No analyte > QL
Laboratory Duplicate	1/20 or per batch	Per laboratory SOP, $\leq 20\%$ RPD	Flag outliers	DESA Analyst	$\leq 20\%$ RPD; ABS $\leq 2 \times$ QL for samples $< 5 \times$ QL
Field Duplicates	1 per 20 samples or per event	None	Data assessor to inform SM if MPC is exceeded; flag results in report	CDM Smith FTL	$\leq 40\%$ RPD if $> 5 \times$ QL otherwise ABS $\leq 2 \times$ QL
LCS or QCS	2 per batch of 20 samples	80-120%R	Identify source of problem, re-prepare and re-analyze or flag outliers	DESA Analyst	80-120%R or as stipulated in laboratory SOP
LCS or QCS Duplicate		$\leq 20\%$ RPD		DESA Analyst	$\leq 20\%$ RPD
Temperature Blank	1 per cooler	0 to 6 degrees Cs	Note outlier in laboratory narrative. Inform CDM of failure and need for additional coolant; check packing procedure	DESA	≤ 6 degrees Celsius

QAPP Worksheet #28m: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Aqueous

Analytical Group Wet Chemistry Anions by-Ion Chromatography (for chloride, sulfate, nitrate, and phosphate)

Analytical Method/SOP Reference EPA 300 or equivalent

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Preparation Blank (PB)	1 per 20 samples	Result $\leq 1/2QL$ No analyte > QL	Suspend analysis; redigest and reanalyze	DESA or subcontract Laboratory Analyst	No analyte > QL
Temperature Blank	1 per cooler	0 to 6 degrees C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant	Laboratory Analyst and CDM Smith FTL	≤ 10 degrees C for data validation
Laboratory Duplicate	1 per 20 samples	$\pm 20\%$ RPD	Flag outliers	DESA or subcontract Laboratory Analyst	$\leq 40\%$ RPD
Field Duplicates	1 per 20 samples	None	Data assessor to inform SM if MPC is exceeded; flag duplicate results	CDM Smith ASC	$\leq 50\%$ RPD, ABS $\leq 5 \times QL$ when either result $\leq 5 \times QL$
Spike Samples	1 per 20 samples	80-120%R-Method A of 300 75 – 125 %R-Method B of 300.	Flag outliers	DESA or subcontract Laboratory Analyst	75 – 125%R
Calibration Standard Verification	Quarterly	90-110%R	Identify source of problem, correct and reanalyze	DESA or subcontract Laboratory Analyst	90-110%R
Laboratory Fortified Blank	1 per 10 samples	80-120%R	Flag outliers	DESA or subcontract Laboratory Analyst	80-120%R

Note:

- Control limits for the LCS must be documented and provided.

QAPP Worksheet #28n: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Aqueous

Analytical Group Wet Chemistry-Anions by Colorimetry; Spectrophotometry (for ammonia)

Analytical Method/SOP Reference EPA 350.1

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Preparation Blank (PB)	1 per 20 samples	None	Suspend analysis; check; redigest and reanalyze	DESA or subcontract Laboratory Analyst	No analyte > QL
Temperature Blank	1 per cooler	0 to 6 degrees C	Increase coolant	CDM Smith FTL	≤ 6 degrees C for data validation
Field Duplicates	1 per 20 samples	None	Data assessor to inform SM if MPC is exceeded; flag duplicate results	CDM Smith ASC	≤40% RPD ABS ≤ 2xQL ² when either result ≤ 5xQL
Laboratory Duplicate	1 per 20 samples	None	Flag outliers	DESA or Subcontract Laboratory Analyst	≤ 40% RPD
Matrix Spike Samples	1 per 20 samples	None	Flag outliers	DESA or subcontract Laboratory Analyst	75 – 125%R
LCS	After calibration, every 20 samples and at end of day	None	Identify source of problem, correct and reanalyze	DESA or Subcontract Laboratory Analyst	80-120%R

1. Control limits for the LCS must be documented and provided.

QAPP Worksheet #28o: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Aqueous
Analytical Group Wet Chemistry—Titration Alkalinity as Bicarbonate
Analytical Method/SOP Reference EPA 310.2 or SM2320

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Preparation Blank (PB)/	1 per 20 samples	None	Suspend analysis; check; redigest and reanalyze	DESA or subcontract Laboratory Analyst	No analyte > QL
Field Duplicates	1 per 20 samples	None	Data assessor to inform SM if MPC is exceeded; flag duplicate results	CDM Smith FTL	≤50% RPD ABS ≤ 2xQL when either result ≤ 5xQL
Laboratory Duplicate	1 per 20 samples	None	Flag outliers	DESA or subcontract Laboratory Analyst	≤ 40% RPD
LCS	After calibration, every 20 samples and at end of day	None	Identify source of problem, recalibrate if needed/ make other adjustments and reanalyze	DESA or subcontract Laboratory Analyst	80-120%R
Temperature Blank	1 per cooler	0 to 6 degrees C	Inform field crew of failure and need for additional coolant; check packing procedure	DESA or subcontract Laboratory Analyst	≤ 6 degrees C for data validation

1. Titrimetric analysis will be performed for alkalinity using SM2320.
2. Control limits for the LCS must be documented and provided.

**QAPP Worksheet #28p: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)**

Matrix Soil/Sediment
Analytical Group TCL VOCs
Analytical Method/SOP Reference SOM02.4

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Notify SM and flag duplicate results.	CDM Smith FTL and Laboratory Analyst	≤100%RPD for sediments; ≤60%RPD for soils ABS ≤ 2xQL when either result < 5xCRQL
Temperature Blank	1 per cooler	0 to 6° C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6° C
Method Blank	1 every 12 hours	No analyte > CRQL*	Suspend analysis unit source recertified.	DESA/CLP laboratory GC/MS technician	No analyte > CRQL*

*Except as noted in the EPA CLP National Functional Guidelines, Final, January 2017

**QAPP Worksheet #28p: Analytical Quality Control and Corrective Action
(TCL VOCs Soils continued)**

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Deuterated Monitoring Compounds	all samples	Vinyl chloride-d3	68-122%R	Check calculations and instruments, reanalyze affected samples; up to three DMCs per sample may fail to meet necessary limits (Section 11.3.4, Page D45 of SOM01.2).	DESA/ CLP laboratory GC/MS technician	Vinyl chloride-d3	68-122%R
		Chloroethane-d5	61-130%R			Chloroethane-d5	61-130%R
		1,1-Dichloroethene-d2	45-132%R			1,1-Dichloroethene-d2	45-132%R
		2-Butanone-d5	20-182%R			2-Butanone-d5	20-182%R
		Chloroform-d	72-123%R			Chloroform-d	72-123%R
		1,2-Dichloroethane-d4	79-122%R			1,2-Dichloroethane-d4	79-122%R
		Benzene-d6	80-121%R			Benzene-d6	80-121%R
		1,2-Dichloropropane-d6	74-124%R			1,2-Dichloropropane-d6	74-124%R
		Toluene-d8	78-121%R			Toluene-d8	78-121%R
		trans-1,3-Dichloropropene-d4	72-130%R			trans-1,3-Dichloropropene-d4	72-130%R
		2-Hexanone-d5	17-184%R			2-Hexanone-d5	17-184%R
		1,4-Dioxane-d8	50-150%R			1,4-Dioxane-d8	50-150%R
		1,1,2,2-Tetrachloroethane-d2	56-161%R			1,1,2,2-Tetrachloroethane-d2	56-161%R
		1,2-Dichlorobenzene-d4	70-131%R			1,2-Dichlorobenzene-d4	70-131%R
Internal Standards	all samples	50-200 percent of area, \pm 30 second retention time shift		Check calculations/ instruments reanalyze affected samples.	DESA or CLP laboratory GC/MS technician	50-100 percent of area, \pm 30 second retention time shift	

**QAPP Worksheet #28p: Analytical Quality Control and Corrective Action
(TCL VOCs Soils continued)**

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Matrix Spike (Not Required)	1 per 20 samples or less (if requested)	1,1-Dichloroethene	59-172%R	Flag outliers.	DESA/ CLP laboratory GC/MS technician	1,1-Dichloroethene	59-172%R
		Trichloroethene	62-137%R			Trichloroethene	62-137%R
		Benzene	66-142%R			Benzene	66-142%R
		Toluene	59-139%R			Toluene	59-139%R
		Chlorobenzene	60-133%R			Chlorobenzene	60-133%R
Matrix Spike Duplicate (Not Required)	1 per 20 samples or less (if requested)	1,1-Dichloroethene	0-22%RPD	Flag outliers.		1,1-Dichloroethene	0-22%RPD
		Trichloroethene	0-24%RPD			Trichloroethene	0-24%RPD
		Benzene	0-21%RPD			Benzene	0-21%RPD
		Toluene	0-21%RPD			Toluene	0-21%RPD
		Chlorobenzene	0-21%RPD			Chlorobenzene	0-21%RPD

QAPP Worksheet #28q: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Soil/Sediment
Analytical Group TCL SVOCs
Analytical Method/SOP Reference SOM02.4

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Notify SM and flag duplicate results.	CDM Smith FTL and Laboratory analyst	$\leq 100\%$ RPD for sediments; $\leq 60\%$ RPD for soils $ABS \leq 2 \times CRQL$ when either result $\leq 5 \times CRQL$
Temperature Blank	1 per cooler	0 to 6°C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6 degrees C
Method Blank	1 per 20 samples or less whenever samples are extracted	No analyte > CRQL*	Suspend analysis and reanalyze blank and affected sample.	DESA or CLP laboratory GC/MS technician	No analyte > CRQL*

*Except as noted in the EPA National Functional Guidelines, Final, January 2017

**QAPP Worksheet #28q: Analytical Quality Control and Corrective Action
(TCL SVOC Soil continued)**

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	DQIs	Measurement Performance Criteria
TCL SVOCs – Soil Continued						
Deuterated Monitoring Compounds	all samples	1,4-Dioxane	40-110%R	Check calculations and instruments, reanalyze affected samples; up to four DMCs may fail to meet recovery limits	DESA or CLP laboratory GC/MS technician	Accuracy
		Phenol-d5	10-130%R			
		Bis(2-chloroethyl)ether- d8	25-120%R			
		2-Chlorophenol-d4	20-130%R			
		4-Methylphenol-d8	25-125%R			
		4-Chloroaniline-d4	1-146%R (advisory)			
		Nitrobenzene-d5	20-125%R			
		2-Nitrophenol-d4	20-130%R			
		2,4-Dichlorophenol-d3	20-120%R			
		Dimethylphthalate-d6	25-130%R			
		Acenaphthylene-d8	10-130%R			
		4-Nitrophenol-d4	10-150%R			
		Fluorene-d10	25-125%R			
		4,6-Dinitro-2- methylphenol-d2	10-130%R			
		Anthracene-d10	25-130%R			
		Pyrene-d10	15-130%R			
		Benzo(a)pyrene-d12	20-130%R			
		Fluoranthene-d10 (SIM)	30-130%R			
		2-Methylnaphthalate- d10 (SIM)	30-130%R			
Internal Standards	all samples	50-200 percent of area, ± 30 second retention time shift	Check calculations and instruments, reanalyze affected samples.	DESA or CLP laboratory GC/MS technician	Accuracy	50-200 percent of area, ± 30 second retention time shift

**QAPP Worksheet #28q: Analytical Quality Control and Corrective Action
(TCL SVOCs Soil/Sediment continued)**

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Matrix Spike/ Matrix Spike Duplicate (Not Required for CLP) Accuracy	1 per 20 samples or less (if requested)	Phenol	12-110%R	Flag outliers.	DESA/ CLP laboratory GC/MS technician	See method acceptance limits
		2-Chlorophenol	27-123%R			
		N-Nitroso-di-n-propylamine	41-116%R			
		4- Chloro-3-methylphenol	23-97%R			
		Acenaphthene	46-118%R			
		4-Nitrophenol	29-94%R			
		2,4-Dinitrotoluene	24-96%R			
		Pentachlorophenol	9-103%R			
		Pyrene	26-127%R			
Matrix Spike/ Matrix Spike Duplicate (Not Required for CLP) Precision	1 per 20 samples if requested (if requested)	Phenol	0-42%RPD	Flag outliers.		
		2-Chlorophenol	0-40%RPD			
		N-Nitroso-di-n-propylamine	0-38%RPD			
		4-Chloro-3-methylphenol	0-42%RPD			
		Acenaphthene	0-31%RPD			
		4-Nitrophenol	0-50%RPD			
		2,4-Dinitrotoluene	0-38%RPD			
		Pentachlorophenol	0-50%RPD			
		Pyrene	0-31%RPD			

QAPP Worksheet #28r: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Soil / Sediment
Analytical Group TCL Pesticides
Analytical Method/SOP Reference SOM02.4

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Field Duplicates	1 per 20 samples	None		Notify SM and flag duplicate results.	CDM Smith ASC and SM	≤100%RPD for sediments; ≤60%RPD for soils when both results ≥ 5xCRQL Otherwise ABS ≤ 2xQL	
Temperature Blank	1 per cooler	0 to 6°C		Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6 degrees C	
Method Blank	1 per ≤20 samples or whenever samples extracted	No analyte > CRQL		Suspend analysis; re-extract and reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	No analyte > CRQL	
Matrix Spike/ Matrix Spike Duplicate Accuracy	1 per ≤20 samples; if requested	Gamma-BHC (lindane)	56-123%R	Flag outliers.	DESA or CLP laboratory GC/ECD technician	Gamma-BHC	56-123%R
		Heptachlor	40-131%R			Heptachlor	40-131%R
		Aldrin	40-120%R			Aldrin	40-120%R
		Dieldrin	52-126%R			Dieldrin	52-126%R
		Endrin	56-121%R			Endrin	56-121%R
		4,4'-DDT	38-127%R			4,4'-DDT	38-127%R

QAPP Worksheet #28r: Analytical Quality Control and Corrective Action (continued)
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)
(TCL Pesticides Soil/Sediment continued)

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Matrix Spike/ Matrix Spike Duplicate Precision	1 per ≤20 samples; if requested	Gamma-BHC (Lindane)	0-15%RPD	Flag outliers.	DESA or CLP laboratory GC/ECD technician	Gamma-BHC	0-15%RPD
		Heptachlor	0-20%RPD			Heptachlor	0-20%RPD
		Aldrin	0-22%RPD			Aldrin	0-22%RPD
		Dieldrin	0-18%RPD			Dieldrin	0-18%RPD
		Endrin	0-21%RPD			Endrin	0-21%RPD
		4,4'-DDT	0-27%RPD			4,4'-DDT	0-27%RPD
LCS	All samples	Heptachlor epoxide	50-150%R	Check calculations and instruments; reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	Heptachlor epoxide	50-150%R
		Dieldrin	30-130%R			Dieldrin	30-130%R
		Gamma-BHC	50-120%R			Gamma-BHC	50-120%R
		4,4'-DDE	50-150%R			4,4'-DDE	50-150%R
		Endrin	50-120%R			Endrin	50-120%R
		Endrin sulfate	50-120%R			Endrin sulfate	50-120%R
		Gamma-Chlordane	30-130%R			Gamma-Chlordane	30-130%R
Surrogate	all samples	30-150%R		Check calculations and instruments; reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	30-150%R	

QAPP Worksheet #28s: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Soil/Sediment
Analytical Group TCL PCBs/Aroclors
Analytical Method/SOP Reference SOM02.4

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits		Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria	
Field Duplicates	1 per 20 samples	None		Notify SM and flag duplicate results.	CDM Smith FTL and Laboratory analyst	$\leq 100\%$ RPD for sediments; $\leq 60\%$ RPD for soils $ABS \leq 2 \times CRQL$ when either $result \leq 5 \times CRQL$	
Temperature Blank	1 per cooler	0 to 6°C		Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C acceptable Validator will apply professional judgment in qualifying data above 6° C	
Method Blank	1 per 20 samples or whenever samples extracted	No analyte > CRQL		Suspend analysis unit source recertified.	DESA or CLP laboratory GC/ECD technician	No analyte > CRQL	
Matrix Spike	1 per 20 samples	Aroclor-1016	29-135%R	Flag outliers.	DESA or CLP laboratory GC/ECD technician	Aroclor-1016	29-135%R
		Aroclor-1260	29-135%R			Aroclor-1260	29-135%R
Matrix Spike Duplicate	1 per 20 samples	Aroclor-1016	0-15%RPD	Flag outliers.	DESA or CLP laboratory GC/ECD technician	Aroclor-1016	0-15%RPD
		Aroclor-1260	0-20%RPD			Aroclor-1260	0-20%RPD
LCS	all samples	Aroclor-1016	50-150%R	Check calculations and instruments; reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	Aroclor-1016	50-150%R
		Aroclor-1260	50-150%R			Aroclor-1260	50-150%R
Surrogate	all samples	30-150%R		Check calculations and instruments; reanalyze affected samples.	DESA or CLP laboratory GC/ECD technician	30-150%R	

QAPP Worksheet #28t: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix
Analytical Group
Analytical Method/SOP Reference

Sediment
Dioxins/Furans
HRSM01.2

Laboratory QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Evaluate during data validation or data assessment – notify project team	Data validator	If both results $\geq 5 \times \text{CRQL}$, RPD $\leq 100\%$ for sediments; $\leq 60\%$ for soils-or ABS $\leq 2 \times \text{CRQL}$
LCS/LCSD	1 per 20 samples	RPD $\leq 30\%$ [Advisory]	Re-extract and reanalyze associated samples	Laboratory Analyst	RPD $\leq 30\%$ [Advisory]
Method/ Instrument Blank	1 per extract batch, not to exceed 20 samples	No target compounds $> \frac{1}{2}$ CRQL (except OCDD/OCDF);	Re-extract and reanalyze if result $> \text{CRQL}$ (except OCDD/OCDF); recalibrate if needed.	Laboratory Analyst	No target compounds $> \frac{1}{2}$ CRQL
Labeled internal standards	Per sample, blank, LCS, LCSD	17-185 %R for LCS 63-170% R for dioxin/furans	The problem will be investigated in accordance with EPA contractual requirements and re-extracted, dilution and/or reanalysis performed as applicable	Laboratory Analyst	17-185 %R for LCS 63-170% R for dioxin/furans
Temperature Blank	1 per cooler	0 to 6 °C	Note outlier in laboratory narrative. Inform field crew of need for additional coolant; check packing procedure	Laboratory Analyst	< 10 °C for data validation
LCS/LCSD	1 per 20 samples	2,3,7,8-TCDD-see MPC column	Identify source of problem, correct and re-extract and reanalyze associated blanks and samples	Laboratory Analyst or supervisor	67-158 %R
		2,3,7,8-TCDF			75-158 %R
		1,2,3,7,8-PeCDD			70-142 %R
		1,2,3,7,8-PeCDF			80-134 %R
		2,3,4,7,8-PeCDF			68-160 %R
		1,2,3,4,7,8-HxCDD			70-164 %R
		1,2,3,6,7,8-HxCDD			76-134 %R
		1,2,3,7,8,9-HxCDD			64-162 %R
		1,2,3,4,7,8-HxCDF			72-134 %R

QAPP Worksheet #28t: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Laboratory QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
LCS/LCSD	1 per 20 samples	1,2,3,6,7,8-HxCDF	Identify source of problem, correct and re-extract and reanalyze associated blanks and samples	Laboratory Analyst or supervisor	84-130 %R
		1,2,3,7,8,9-HxCDF			78-130 %R
		2,3,4,6,7,8-HxCDF			70-156 %R
		1,2,3,4,6,7,8-HpCDD			70-140 %R
		1,2,3,4,6,7,8-HpCDF			82-132 %R
		1,2,3,4,7,8,9-HpCDF			78-138 %R
		OCDD			78-144 %R
		OCDF			63-170 %R

**QAPP Worksheet #28u: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)**

Matrix Soil/Sediment
Analytical Group TAL Metals
Analytical Method/SOP Reference ISM02.4

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Notify SM; flag duplicate results.	Laboratory analyst and CDM Smith FTL	≤100%RPD for sediments; ≤60% RPD for soils - ABS ≤ 2xCRQL when either result ≤ 5xCRQL
Temperature Blank	1 per cooler	0 to 6°C	Laboratory inform RSCC/CDM Smith - note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C - Validator will apply professional judgment in qualifying data above 6° C
Preparation Blank	1 per 20 samples	No constituent > CRQL	Suspend analysis until source rectified; re-digest and reanalyze affected samples.	DESA or CLP laboratory ICP-AES/ICP-MS technician	No constituent > CRQL
Spike	1 per 20 samples	75-125%R*	Flag outliers.		75-125%R*
Laboratory Duplicate	1 per 20 samples	≤35% RPD**	Flag outliers.		≤ 35%RPD**
Post-Digestion Spike	After an analyte (except Ag & Hg) fails spike %R	75-125%R	Flag outliers.		75-125%R
Interference Check Sample [ICP Analysis Only]	Beginning, end, and periodically during run (2 times every 8 hours)	Within ± 2 times CRQL of true value or ± 20 percent of true value, whichever is greater	Check calculations and instruments; reanalyze affected samples.		Within ± 2 times CRQL of true value or ± 20 percent of true value, whichever is greater
LCS	1 per 20 samples	70-130 %R (Sb and Ag 50-150%R)	Suspend analysis rectify source; re-digest and reanalyze affected samples.		70-130 %R (Sb and Ag 50-150%R)

*When the sample concentration is greater than 4 times the spike concentration, no data validation action taken.

**Reference EPA Region 2 SOP No. HW-2, Revision 13/Evaluation of Metals Data for CLP - (include ABS criteria)

*** If the EPA LCS is unavailable, other EPA QC samples or other certified materials may be used. In such cases, control limits for the LCS must be documented and provided.

QAPP Worksheet #28v: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Soil/Sediment
Analytical Group TAL – Total Cyanide
Analytical Method/SOP Reference ISM02.4– Colorimeter or Spectrophotometer

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Notify SM and flag duplicate results.	CDM Smith FTL and Laboratory analyst	≤100%RPD for sediments; ≤60%RPD for soils ABS ≤ 2xCRQL when either result ≤ 5xCRQL
Temperature Blank	1 per cooler	0 to 6°C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C
Equipment Blank	1 per decontamination event not to exceed 1 per day	≤ CRQL	Verify results; re-analyze. Flag outliers. Check decontamination procedures.	Laboratory analyst and CDM Smith FTL	≤ CRQL
Preparation Blank (PB)	1 per ≤20 samples	No analyte > CRQL	Suspend analysis; redigest and reanalyze.	DESA or CLP laboratory technician	No analyte > CRQL
Laboratory Duplicate	1 per ≤20 samples	≤ 35%RPD	Flag outliers.	DESA or CLP laboratory technician	≤ 35%RPD
Spike Sample	1 per ≤20 samples	75-125%R	Flag outliers.	DESA or CLP laboratory technician	75-125%R

**QAPP Worksheet #28w: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)**

Matrix Soil

Analytical Group TAL – Total Mercury – Cold Vapor Atomic Absorption (CVAA)

Analytical Method/SOP Reference ISM02.4

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field Duplicates	1 per 20 samples	None	Notify SM and flag duplicate results.	CDM Smith FTL and Laboratory analyst	≤100%RPD for sediments; ≤60%RPD for soils ABS ≤ 2xCRQL when either result ≤ 5xCRQL
Temperature Blank	1 per cooler	0 to 6°C	Laboratory will inform RSCC/CDM Smith and note in data narrative. CDM Smith will check packing procedure and increase coolant.	Laboratory analyst and CDM Smith FTL	0 to 6° C Validator will apply professional judgment in qualifying data above 6 degrees C
Equipment blank	1 per decontamination event not to exceed 1 per day	≤ CRQL	Verify results; re-analyze. Flag outliers. Check decontamination procedures.	Laboratory analyst and CDM Smith FTL	≤ CRQL
Preparation Blank (PB)	1 per ≤20 samples	No analyte > CRQL	Suspend analysis; redigest and reanalyze if blank results meet criteria outlined in SOP.	DESA or CLP laboratory technician	No analyte > CRQL
Laboratory Duplicate	1 per 20 samples	≤ 20%RPD	Flag outliers.	DESA or CLP laboratory technician	≤ 35%RPD
Spike Sample	1 per ≤20 samples	75-125%R	Flag outliers and perform post-digestion spike. No flags required if sample concentration is >4x spike added.	DESA or CLP laboratory technician	75-125%R

QAPP Worksheet #28x: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Sediment
Analytical Group Methylmercury
Analytical Method/SOP Reference BAL-3200/EPA 1630, Modified

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field duplicates	1 per 20 samples	≤40% RPD when both results ≥ 5xQL	Data assessor to inform SM if MPC is exceeded; address in DQA	CDM Smith FTL and Laboratory Analyst	≤ 60% RPD for results ≥ 5QL or ABS <2xQL
Method Blank	4 per 20 samples or batch	No result > 1/10 of sample results or average ≤0.045ng/L	Suspend analysis until source rectified; re-distill and reanalyze affected samples if results are <10 times the blank	Laboratory Analyst	No result > QL
Laboratory duplicate	1 per 20 samples	≤ 35% RPD or ABS< 2xQL if sample result< 5xQL	Investigate and correct. Multiple failures require re-distillation and reanalysis.		≤ 35% RPD if both results >5MDL
Ongoing Precision and Recovery (SRM)	1 per 20 samples	Within control chart limits or 35%R of certified value after recovery correction	Check calculations and instruments, re-prepare SRM and reanalyze.		67-133%R of true value
MS/MSD	1 per 20 samples	65-135%R	Investigate matrix effects and note in data narrative. If RPD criterion is not met, the system is out of control - correct problem and reanalyze all affected samples.		65-135%R
MS/MSD		≤ 35% RPD			≤ 35% RPD

**QAPP Worksheet #28y: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)**

Matrix

Sediment

Analytical Group

6 Step Selective Sequential Extractions for Mercury (Includes volatile mercury analysis as the F0 step)

Analytical Method/SOP Reference

BAL-3900 or equivalent with Mercury analysis EPA 1631E, or equivalent

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Analytical Spike	1 per 20 samples	77-123% R for samples after sequential extraction; 75 -130 % R for samples without sequential extraction	Flag outliers. Re-analysis at higher dilution may be necessary if matrix interference is suspected.	Laboratory Analyst	75-125%R*
Analytical Duplicate	1 per 20 samples	RPD < 35% for samples after sequential extraction; RPD < 30%; results < 5x the MRL and \pm 2x the MRL of each other for soil samples without sequential extraction	Flag outliers. Re-analysis may be necessary.		\leq 35% RPD**
Method Blank	1 per 20 samples	\leq QLs	Per laboratory SOP		\leq QLs and meets PAL on WS#15
LCS	1 per 20 samples	70-130 %R	Per laboratory SOP		70-130 %R

*Except when the sample concentration is greater than 4 times the spike concentration, then disregard the recoveries; no data validation action taken.

**Except when the sample and/or duplicate concentration is less than 5 times the QL, then + QL.

QAPP Worksheet #28z: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Soil/ Sediment
Analytical Group Grain Size
Analytical Method/SOP Reference ASTM D6913 and D7928

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Laboratory Duplicate	1 per sample	None	Flag outliers.	DESA or Subcontract Laboratory Analyst	≤40% RPD

QAPP Worksheet #28aa: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Soil/ Sediment

Analytical Group TOC using Carbon analyzer + IR or FID detector

Analytical Method/SOP Reference Lloyd Kahn with additional QC requirements

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Preparation Blank	1 per 20 samples	≤ 100 mg/kg	Verify results; reanalyze; recalibrate if still outlying	DESA or subcontract Laboratory Analyst	\leq QL
Laboratory Duplicate	Every sample	$\leq 20\%$ RPD	Re-run sample; flag outliers	DESA or subcontract Laboratory Analyst	$\leq 35\%$ RPD
Quadruplicate analysis	Per batch	$< 3 \times$ Standard deviation	Identify error and re-analyze	Laboratory analyst	$< 3 \times$ Standard deviation
Detection Limit Verification Standard	1 per sample run	$\pm 25\%$ of true value	Identify error and re-analyze	Laboratory analyst	$\pm 25\%$ of true value
Field Duplicates	1 per 20 samples	None	Data assessor to inform SM if MPC is exceeded; flag duplicate results	CDM Smith ASC	$\leq 60\%$ RPD ABS $\leq 2 \times$ QL when either result $\leq 5 \times$ QL
Temperature Blank	1 per cooler	0 to 6 degrees C	Inform field crew of failure and need for additional coolant; check packing procedure	DESA or subcontract Laboratory Analyst	≤ 6 degrees C for data validation

QAPP Worksheet #28ab: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Soil/Sediment
Analytical Group Moisture Content
Analytical Method/SOP
Reference ASTM D2216

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Laboratory duplicate	1 per 20 samples or with each group of field samples	≤ 20% RPD	Investigate and correct; reanalyze affected samples. Flag outliers. Document in case narrative.	Laboratory Analyst	≤ 40% RPD

QAPP Worksheet #28ac: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Matrix Gas/Air (Solid Sorbent Tube)
Analytical Group Mercury
Analytical Method/SOP NIOSH 6009
Reference

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Measurement Performance Criteria
Field duplicate	One per analytical batch of up to 20 samples	None	Data assessor to inform site manager and FTL if MPC is exceeded; flag duplicate results	CDM Smith FTL and ASC	≤30%RPD
Method blank	One per analytical batch of up to 20 samples	No target compounds >RL	Identify source and attempt to eliminate. Reanalyze blank and affected samples (if sufficient sample remains). Qualify data as needed. If contamination is widespread or reoccurring, analyses must be stopped and the source of contamination must be eliminated or reduced before analyses can continue.	Analyst/Laboratory Quality Assurance Officer	No target compounds > RL
LCS/LCSD	One per analytical batch of up to 20 samples	75-125%R; RPD ≤ 20%	Correct problem; reanalyze LCS and all samples in associated batch for failed analytes. If problem persists, contact QA Officer. If LCS has elevated recovery and sample is non-detect for that analyte, narrate and report	Analyst/Laboratory Quality Assurance Officer	75-125%R; RPD ≤ 20%
Laboratory duplicate	One per batch of up to 20 samples	RPD < 30%	If one result is detected > 5x RL and one is not detected, the analysis must be repeated. If the LCS/LCSD meet criteria then report results.	Analyst/Laboratory Quality Assurance Office	≤ 30% RPD

* Sorbent tube samples will be analyzed for mercury with either NIOSH 6009 or EPA 324 methods depending on laboratory availability.

**QAPP Worksheet #28ae: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)**

PROCEDURE FOR COLLECTION OF FIELD QC SAMPLES

Duplicates: Field duplicate samples are collected and analyzed to assess the overall precision of the field sampling technique. Duplicate samples, of the same matrix, will be collected at a rate of five percent (one per 20 samples) or one per every 14 days or one if less than 20 samples are collected. These duplicates will be submitted "blind" to the laboratories by using sample numbers that differ from their associated environmental samples. For groundwater samples collected during the sampling event, duplicate samples will be collected on a per event basis.

Duplicate samples will be collected by alternately filling bottles for the same analysis.

Trip Blanks: A trip blank will be prepared at the start of each day on which aqueous samples will be collected for analysis of VOCs. Trip blanks are used to determine whether on site atmospheric contaminants are seeping into the sample vials, or if any cross-contamination of samples is occurring during shipment or storage of sample containers. A trip blank consists of demonstrated analyte-free water sealed in 40-mL Teflon septum vials with no headspace (including bubbles) in the vials. Trip blank water will be considered analyte-free when analysis results for VOCs are below the associated quantitation limit.

Certification of blank water quality will be kept on site and will be filed in the project files once field work is completed. A sample of the blank water used in the field will be submitted for confirmatory analysis.

Trip blanks are to be kept in close proximity to the samples being collected and will be maintained at 6 °C. They will be handled in the same manner as the other VOC aqueous samples. Preservation of trip blanks is presented on Worksheet #19. One trip blank will be included with each cooler that contains aqueous samples collected for VOC.

Equipment Blanks: Equipment blanks will be collected to evaluate field sampling and decontamination procedures by pouring demonstrated analyte-free water over or through the decontaminated sampling equipment. Equipment blanks are used to assess the effectiveness of equipment decontamination and will be collected before the use of decontaminated sampling equipment. One equipment blank will be collected for each equipment type per decontamination event and will be analyzed for the same constituents as the environmental samples. The frequency of equipment blanks is one per decontamination event, not to exceed one per day, for each equipment type and for each sample matrix. If disposable sampling equipment will be used, no rinsate blanks are required.

The definition of demonstrated analyte-free water is discussed in the previous section. The use of the same aliquot of water on all equipment associated with a particular matrix for the required analyses is permissible. However, a separate equipment blank may be collected for each piece of equipment associated with a particular sample matrix that will be analyzed.

QAPP Worksheet #28ae: Analytical Quality Control and Corrective Action
(UFP-QAPP Manual Section 3.4 and Tables 4, 5, and 6)
(EPA 2106-G-05 Section 2.3.5)

Equipment Blanks (Continued):

Equipment blanks may be minimized by decreasing the frequency of decontamination and using additional equipment. In this case the samples associated with the equipment blank will be noted in the field logbooks and sample trip report. Equipment blank samples should be analyzed prior to environmental samples.

Cooler Temperature Indicators: One cooler temperature indicator or “temperature blank” will be placed in each cooler containing samples (solid and aqueous) being sent to the laboratory for analysis. The temperature blank will consist of a sample container filled with non-preserved water (potable or distilled). The container will be labeled “COOLER TEMPERATURE INDICATOR” and dated.

Matrix Spikes: Matrix spikes are not required for VOCs and SVOCs for sampling going through the CLP; they are required for the DESA laboratory. CLP laboratories will require additional volume for MS/MSDs for pesticides, PCBs, and dioxins/furans. DESA will not require additional volume for MS/MSDs for water quality parameters; they are not required for geotechnical parameters. The subcontract laboratory will likely require additional volume for MS/MSDs for the specialty mercury analyses.

QAPP Worksheet #29: Project Documents and Records
(UFP-QAPP Manual Section 3.5.1)
(EPA 2106-G-05 Section 2.2.8)

Sample Collection and Field Records			
Record	Generation (CDM Smith)	Verification (CDM Smith)	Storage Location/Archival
Air Bills	FTL	FTL or designee	Project file
ANSETS	CDM Smith project manager	ASC	Project file
Correspondence	Site manager	Site manager or designee	Project file
Data Usability Assessment Report	ASC or designee	Chemist	Project file
Data Validation Report	Data validator	Chemist	Project file
Data Verification Checklists	FTL	ASC	Project file
Deviations – Field Change Request	FTL	SM	Project file
Field Logbook or Data Collection Sheets	FTL	FTL	Project file
Project Assessments			
Photographic Log	FTL or designee	Task manager or designee	Project file
Sample Tracking Forms	Sample manager or designee	FTL or designee	Project file
Scribe Chain-of-Custody Forms	Sample manager or designee	FTL or designee	Project file
Laboratory Records			
Bid Sheets, Scopes of Work (if a subcontract laboratory is required)	SM or designee	Technical reviewer and procurement specialist	Procurement file
Laboratory Data Packages	Laboratory QA officer	Chemist or QA specialist	EPA file
Laboratory QA Plans	Laboratory QA officer	Chemist or QA specialist	Procurement file
SOPs	Laboratory QA officer	Chemist or QA specialist	Procurement file

Note: See Appendix B for field forms.

QAPP Worksheet #29: Project Documents and Records (continued)
(UFP-QAPP Manual Section 3.5.1)
(EPA 2106-G-05 Section 2.2.8)

Laboratory Data Deliverables				
Record	Organics	Metals, Mercury, Cyanide	Water Quality/ Soil Characteristics	Complex Mercury Analyses
Narrative	X	X	X	X
COC	X	X	X	X
Summary Results	X	X	X	X
Analytical sample results	X	X	X	X
QC Results	X	X	X	X
Chromatograms	X	NA	NA	NA
Sample Preparation Log	X	X	X	X
Sample Run Log	X	X	X	X
Tentatively Identified Compounds (TICs)	NA	NA	NA	NA
Raw Data	X	X	X	X

Raw data shall include the calibration information.

**QAPP Worksheet #31, #32 and #33: Assessments and Corrective Action
(UFP-QAPP Manual Sections 4.1.1 and 4.1.2)
(EPA 2106-G-05 Section 2.4 and 2.5.5)**

Assessment Type	Number/ Frequency	Organization	Responsible Party	Assessment Deliverable and Due Dates	Party to Identify and Implement Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
					Title and Organizational Affiliation	
Project Readiness Review	Prior to field work	CDM Smith	FTL	Immediately; to within 24 hours of review.	SM, CDM Smith	Edward Leonard (SM), CDM Smith
Sample Collection and Documentation QC checks	Once per overall field program	CDM Smith	FTL	Email within 24 hours.	SM, CDM Smith	Jeniffer Oxford (QAS), CDM Smith
QAPP	Annually	CDM Smith	Approved CDM Smith QA staff or QA coordinator	E-mail/FCR if required.	SM, CDM Smith	Edward Leonard (SM), CDM Smith
Data Usability Evaluation	Once after receipt of data and database review and release	CDM Smith	Troy Gallagher or designee	Memorandum based on project requirements.	Project chemist, FTL, or SM, depending on nature of issue	Edward Leonard (SM), CDM Smith

Notes:
1. Findings and deviations from plans will require corrective actions, which will be documented and discussed appropriately. The EPA RPM will be notified by the CDM Smith SM.

**QAPP Worksheet #34: Data Verification and Validation Inputs
(UFP-QAPP Manual Section 5.2.1 and Table 9)
(EPA 2106-G-05 Section 2.5.1)**

Item	Input	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records				
1	QAPP	All planning documents will be available to reviewers to allow reconciliation with planned activities and objectives.	X	X
2	Field Technical SOPs		X	X
3	Laboratory SOPs		X	X
Field Records				
4	Field logbooks	Field notes will be prepared daily by the field team and will be complete, appropriate to the project tasks, and legible. The FTL will review logbooks and records for accuracy and completeness. Upon completion of fieldwork, logbooks and records will be placed in the project files. Field reports will be verified to ensure correct reporting of information. Review will be conducted prior to completion of each report.	X	X
			X	X
5	COC	Sample manager, FTL, or designee will review the COC forms against the samples packed in each cooler prior to shipment. COCs will be sent with the samples to the laboratory and copies retained for the trip report and project files. The data validator will review COC forms upon completion of analytical activities and verify against the laboratory report.	X	X
6	Sampling Trip Reports	FTL or designee; laboratory coordinator will review these for each case of field sampling for which samples are sent to a CLP laboratory. Information will be reviewed against the COC forms, and potential discrepancies will be discussed with field personnel to verify locations, dates, etc.	X	X
7	Correspondence	Relevant correspondence will be used to reconcile field records and data.	X	X
8	Field Change Requests	ASC and data evaluator will review during completion of each data usability assessment/measurement report.	X	X

QAPP Worksheet #34: Data Verification and Validation Inputs
(UFP-QAPP Manual Section 5.2.1 and Table 9)
(EPA 2106-G-05 Section 2.5.1)

Item	Input	Description	Verification (completeness)	Validation (conformance to specifications)
Analytical Data Package				
9	Laboratory analytical data packages	Laboratory analyst and QA officer will review/verify internally the completeness and technical accuracy of data prior to submittal. All laboratory data will be verified by the laboratory performing the analysis prior to submittal. EPA DV contractor-data validator or CDM Smith data validator will review data packages for content and sample information upon receipt. Data packages will be evaluated for completeness and compliance. Table 9 of the Intergovernmental Data Quality Task Force UFP-QAPP shows items for compliance review.	X	X
10	Communication Records	Relevant correspondence will be used to reconcile analytical data.	X	X
11	EDDs fields	Data manager will determine whether required EQuIS compatible EDD fields and format were provided.	X	X
12	Outputs of the EQuIS database	Project task leader and team will compile the project data results in a sample project report. Data tables, figures, and reported entries will be reviewed/verified against hardcopy information or EQuIS output.	X	X
13	Data validation and audit reports, QAPP, and FCRs	Data assessor will prepare the project data quality and usability assessment report. The data will be evaluated against project DQOs and measurement performance criteria such as completeness. Evaluate whether field sampling procedures were followed with respect to equipment and proper sampling support.	X	X

QAPP Worksheet #35: Data Verification Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Requirement Documents	Records Reviewed	Process Description	Responsible Person /Organization
QAPP, Technical SOP 4-1	Field logbook	Verify records are present and complete for each day of field activities. Verify all planned samples, including field QC samples were collected and sample collection locations are documented. Verify meteorological data were provided for each day of field activities and changes/exceptions are documented and reported in accordance with requirements. Verify any required field monitoring was performed and results are documented.	Daily – FTL At conclusion of field activities – project QC staff
SOPs	Field logbook and FCRs	Ensure the sampling methods/procedures outlined in the QAPP were followed and any deviations were noted/approved. Determine potential impacts from noted/approved deviations, regarding project quality objectives (PQOs).	FTL
QAPP, Technical SOP 1-2	COC forms	Verify the completeness of COC records. Examine entries for consistency with the field logbook. Check that appropriate methods and sample preservation have been recorded. Verify the required volume of sample has been collected and sufficient sample volume is available for QC samples (e.g., MS/MSD). Verify all required signatures and dates are present. Check for transcription errors.	Daily – FTL At conclusion of field activities – project chemist or data assessor
QAPP, Technical SOP 1-2	COC	Examine traceability of data from sample collection to generation of project reported data. Provide sampling dates and time, verification of sample ID, and QC sample information.	At conclusion of field activities – project QC staff (data manager, data validator)
QAPP	Laboratory data package	Examine packages against QAPP and laboratory contract requirements and against COC forms (e.g., holding times, sample handling, analytical methods, sample identification, data qualifiers, and QC samples). Determine potential impacts from noted/approved deviations regarding PQOs.	Environmental Services Assistance Team (ESAT) data validation personnel, EPA Region 2 or CDM Smith Data validator

**QAPP Worksheet #35: Data Verification Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)**

Requirement Documents	Records Reviewed	Process Description	Responsible Person /Organization
QAPP	Laboratory deliverable	Verify the laboratory deliverable contains all records specified in the subcontract SOW. Check sample receipt records to ensure sample condition upon receipt was noted, and any missing/broken sample containers were noted and reported according to plan. Compare the data package with the COCs to verify results were provided for all collected samples. Review the narrative to ensure all QC exceptions are described. Check for evidence that any required notifications were provided to project personnel as specified in the QAPP. Verify necessary signatures and dates are present.	Before release – Laboratory QAM Upon receipt – project chemist or data validator (ESAT or CDM Smith data validation personnel or ASC)
	Audit reports, corrective action reports	Verify all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify corrective action was implemented according to plan.	Contract QAS
	Methods	Verify records support implementation of the SOP sampling and analysis.	CDM Smith ASC, data validator, or data assessor
	Data narrative	Determine deviations from methods and contract and the impact.	
	Project quantitation limit	Verify achievement of PQLG as established in the QAPP and the laboratory successfully analyzed a standard at the QL.	
	Field and laboratory data and QC report	A summary of all QC samples and results will be verified for measurement performance criteria, completeness, and 10 percent verified to field and laboratory data reports from vendors. A report on meeting the established criteria shall be prepared within 30 days of receipt.	

QAPP Worksheet #36: Data Validation Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Validation Code and Label Identifier Table

Validation Code*	Validation Label	Description/Reference	
S1VE	Stage 1 Validation Electronic	Stage 1 Validation - Verification and validation based only on completeness and compliance of sample receipt condition checks.	EPA 540-R-08-005
S1VM	Stage 1 Validation Manual		
S1VEM	Stage 1 Validation Electronic and Manual		
S2aVE	Stage 2a Validation Electronic	Stage 2A Validation - Verification and validation based on completeness and compliance checks of sample receipt conditions and ONLY sample-related QC results.	
S2aVM	Stage 2a Validation Manual		
S2aVEM	Stage 2a Validation Electronic and Manual		
S2bVE	Stage 2b Validation Electronic	Stage 2B Validation - Verification and validation based on completeness and compliance checks of sample receipt conditions and BOTH sample-related and instrument-related QC results.	
S2bVM	Stage 2b Validation Manual		
S2bVEM	Stage 2b Validation Electronic and Manual		
S3VE	Stage 3 Validation Electronic	Stage 3 Validation - Verification and validation based on completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, AND recalculation checks.	
S3VM	Stage 3 Validation Manual		
S3VEM	Stage 3 Validation Electronic and Manual		
S4VE	Stage 4 Validation Electronic	Stage 4 Validation - Verification and validation based on completeness and compliance checks of sample receipt conditions, both sample-related and instrument-related QC results, recalculation checks, AND the review of actual instrument outputs.	
S4VM	Stage 4 Validation Manual		
S4VEM	Stage 4 Validation Electronic and Manual		
NV	Not Validated		

Note:

The following data qualifiers will be applied during data validation by a third party. Potential impacts on project DQOs will be discussed in the data validation report.

NM – Measurement Performance Criteria contained in WS#12 were not met.

J – The result is an estimated value. The nature of the bias will be discussed in the data validation report.

E – Erroneous result (e.g., improper calculation, peak integration, etc.)

R – Rejected data

QAPP Worksheet #36: Data Validation Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Analytical Group/Method	Data deliverable requirements	Analytical specifications	Measurement performance criteria	Percent of data packages to be validated ¹	Percent raw data review/percent results to recalculate	Validation Procedure ³	Validation code	Electronic validation program/version	Data Validator
FASTAC Tiers 1 and 2 (DESA or CLP)									
VOCs	SEDD Stage 3	SOM02.4	Worksheet #12 and Worksheet #28	100 percent	100 percent/10 percent	SOP HW-34, Rev 3, DESA Worksheet #35 or NFG	S3VEM	EXES	ESAT DV staff, or DESA
SVOCs	SEDD Stage 3	SOM02.4				SOP HW-35, Rev 2, DESA Worksheet #35	S3VEM	EXES	ESAT DV staff, or DESA
Pesticides	SEDD Stage 3	SOM02.4				SOP HW-36, Rev 0	S3VEM	EXES	ESAT DV staff, or DESA
PCBs Aroclors	SEDD Stage 3	SOM02.4				SOP HW-37, Rev 0	S3VEM	EXES	ESAT DV staff, or DESA
Dioxins/Furans	SEDD Stage 3	HRSM01.2				SOP HW 19, Rev 1 or NFG	S3EVM	EXES	ESAT DV staff
TAL Metals (ICP-AES)	SEDD Stage 2B	ISM02.4				SOP HW-2a, Rev 15 or NFG	S2BVEM	EXES	ESAT DV staff, or DESA
TAL Metals (ICP-MS)		ISM02.4				SOP HW-2b, Rev 15 or NFG			
TAL Metals (Mercury)		ISM02.4				SOP HW-2a, Rev 15 or NFG			

QAPP Worksheet #36: Data Validation Procedures
(UFP-QAPP Manual Section 5.2.2)
(EPA 2106-G-05 Section 2.5.1)

Analytical Group/Method	Data deliverable requirements	Analytical specifications	Measurement performance criteria	Percent of data packages to be validated ¹	Percent raw data review/percent results to recalculate	Validation Procedure ³	Validation code	Electronic validation program/version	Data Validator
FASTAC Tiers 1 and 2 (DESA or CLP) [Continued]									
TAL Metals (Cyanide)	SEDD Stage 2B	ISM02.4	Worksheets #12 and #28	100 percent	100 percent/10 percent	SOP HW-2a, Rev 15 or NFG	S2BVEM	EXES	ESAT DV staff, or DESA
Wet Chemistry	EQuIS Region 2 compliant EDD	DESA SOPs				DESA SOP and Worksheet #35 or NFG	S2BVM	NA	ESAT DV staff, or DESA
Grain size and percent solids	EQuIS Region 2 compliant EDD	DESA SOPs		0 percent	0 percent	No data validation	NA	NA	NA
FASTAC Tier 4 (CDM Smith Subcontract Laboratory)									
Methylmercury	EQuIS Region 2 compliant EDD	BAL-3200	Worksheets #12 and #28	100 percent	10 percent/5 percent	NFG modified by Worksheets #12 and #28 and method SOP	S3VM	NA	CDM Smith DV staff
Mercury by sequential extraction	EQuIS Region 2 compliant EDD	BAL-3900	Worksheets #12 and #28	100 percent			S3VM	NA	CDM Smith DV staff
Mercury Vapor/Air	EQuIS Region 2 compliant EDD	NIOSH 6009	Worksheets #12 and #28	100 percent			S3VM	NA	CDM Smith DV staff

**QAPP Worksheet #37: Data Usability Assessment
(UFP-QAPP Manual Section 5.2.3 including Table 12)
(EPA 2106-G-05 Section 2.5.2, 2.5.3, and 2.5.4)**

Personnel (organization and position/title) responsible for participating in the data usability assessment:

CDM Smith SM – Edward Leonard
CDM Smith Data Coordinator –Tonya Bennett

The following steps will be taken in preparing the data usability assessment:

Step 1 – Review the project’s objectives and sampling design

Review the sampling design documented in the QAPP for consistency with stated objectives. This provides the context for interpreting the data in subsequent steps.

Step 2 – Review the data verification and data validation outputs

Review available QA reports, including the data verification and data validation reports. Look for patterns, trends, and anomalies (i.e., unexpected results). Review deviations from planned activities (e.g., number and locations of samples, holding time exceedances, damaged samples, non-compliant sample results, and SOP deviations), audits or assessments and determine their impacts on the data usability. Evaluate implications of unacceptable QC sample results.

Step 3 – Verify the assumptions of the selected statistical method

N/A

Step 4 – Implement the statistical method

N/A

Step 5 – Document data usability and draw conclusions

Determine if the data can be used as intended, considering implications of deviations and corrective actions. Discuss DQIs. Assess the performance of the sampling design and identify limitations on data use. Prepare the data usability summary report in the form of text and/or a table.

The usability assessment will be documented as follows:

The CDM Smith SM will assign tasks to the individuals supporting the data usability assessment. The data usability assessment will be conducted on validated data. The results of the data usability assessment will be presented in the data evaluation report. The following items will be assessed and conclusions drawn based on their results.

QAPP Worksheet #37: Data Usability Assessment (continued)
(UFP-QAPP Manual Section 5.2.3 including Table 12)
(EPA 2106-G-05 Section 2.5.2, 2.5.3, and 2.5.4)

Precision – Results of laboratory duplicates will be assessed during data validation, and data will be qualified according to the data validation procedures cited on Worksheet #36. Field duplicates will be assessed by matrix using RPD acceptance criteria, presented in Worksheet #12, will be used to assess analytical comparability. Absolute difference will be used when one or both results are at or below five times QL (see Worksheets 12 and 28). An absolute difference of less than twice the QL will be the acceptance criteria (see Worksheets #12 and 28 for specific criteria). A discussion summarizing the results of laboratory and field precision and any limitations on the use of the data will be described in the RI Report.

To calculate field duplicate precision:

$$\text{RPD} = 100 \times 2 |X1 - X2| / (X1 + X2) \quad \text{where } X1 \text{ and } X2 \text{ are the reported concentrations for sample and duplicate results}$$

Accuracy/Bias Contamination – Laboratory blank results will be assessed as part of data validation. During the data validation process, the validator will qualify the data following the procedures listed on Worksheet #36. A discussion summarizing the results of laboratory accuracy and bias based on contamination will be presented in the data usability assessment.

Overall Accuracy/Bias – The results of instrument calibration and matrix spike recoveries will be reviewed, and data will be qualified according to the data validation procedures cited on Worksheet #36. A discussion summarizing the results of laboratory accuracy and any limitations on the use of the data will be described in the data usability assessment.

Sensitivity – Data results will be compared to criteria (PALs, PQLGs) provided on Worksheet #15. A discussion summarizing any conclusions about sensitivity of the analyses will be presented, and any limitations on the use of the data will be described in the Data Usability Report.

Representativeness – A review of adherence to the sampling plan and QAPP will be performed to assess the representativeness of the sampling program. Data validation narratives also will be reviewed, and any conclusions about the representativeness of the data set will be discussed.

Comparability – Study results will be used in conjunction with existing data to make qualitative and quantitative assessments of the data to be used to produce the site reports.

Reconciliation – The results of the DQIs presented in Worksheet #12 will be examined to determine if the MPCs were met. This examination will include a combined overall assessment of the results of each analysis pertinent to an objective. Each analysis will first be evaluated separately in terms of major impacts observed from data validation, DQIs, and measurement performance criteria assessments. Based on the results of these assessments, the quality of the data will be determined. The data quality will be used to determine usability of the data and if project goals were achieved. As part of the reconciliation of each objective, conclusions will be drawn, and any limitations on the usability of any of the data will be described.

QAPP Worksheet #37: Data Usability Assessment (continued)
(UFP-QAPP Manual Section 5.2.3 including Table 12)
(EPA 2106-G-05 Section 2.5.2, 2.5.3, and 2.5.4)

Completeness – A completeness check will be done on analytical data using database queries. Completeness will be calculated for each analyte by matrix and compared to the project completeness goal of 90 percent. The calculations below will be used to assess completeness based on the number of samples collected versus the number planned to be collected and based on the number of valid data generated. A discussion summarizing the results of project completeness and any limitations on the use of the data will be described in the report.

The following equations will be used:

To calculate completeness:

$\% \text{ Completeness} = V/n * 100$ where V= number of measurements judged valid; n = total number of measurements made and

$\% \text{ Completeness} = C/X * 100$ where C= number of samples collected; X = total number of measurements planned

The results will be evaluated using temporal and spatial relationships of the data. This activity will be performed during the data usability evaluation and RI reporting. Not all “J” qualified data are usable so all lines of evidence to support data use will be evaluated. Although “J” data are reasonable for use, CDM Smith will also document the evaluation of all qualified results against the values, data quality, and bias of surrounding data. If needed, qualified results at plume edges will be mapped and evaluated. Validated results will be further examined during data evaluation and re-coded in accordance with EPA Region 2 directives.

For qualified results that are outliers or at the edge of contaminated areas:

- a) Discuss how data outliers will be addressed
- b) Evaluate against all issues such as geology, hydrogeology, depth, past history
- c) Consider whether qualified data are reasonable based on surrounding data (e.g., data qualified due to missed holding time may be lower than we expect)
- d) Address data quality bias and reason for qualification
- e) Evaluate effect of data qualification on the data

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Tables

Table 1
Sample Summary and Analyses
Pierson's Creek Site OU1
Newark, New Jersey

Field Event	Section	Sampling Identification***	Sampling Locations	Sample Location Rationale	Sampling/Measurement Activities						
					Sampling Frequency / Intervals	Analytical Parameters				Field Parameters	Total Samples*
						CLP Analyses	DESA Analyses	Subcontract Analyses	Analytical Rationale		
Sediment Sampling Program											
Sediment Sampling	Upper Creek Section	In Pierson's Creek: TXX-X-SE; in drainage ditches: DXX-SE	13	Samples are spaced approximately 100 feet apart in Pierson's Creek south of the Troy Chemical property; samples are spaced approximately 200 feet apart in tributaries; seven samples are taken from each core to ensure that there is proper vertical delineation of contamination from the surface to the native material	0 to 0.5, 0.5 to 1, 1 to 2, 2 to 3, 3 to 4 and 4 to 5 feet, and top 6 inches of native sediment	TCL VOCs, SVOCs, Pesticides, and PCBs; TAL Metals and Hg, CN	Grain size, TOC, % solids	Methylmercury from all sample intervals; Volatile mercury from 2 samples per core; Dioxins/ Furans from transect locations (22 cores) at all sample intervals; Mercury by sequential extraction at 0-0.5 feet sample interval	<i>Methylmercury</i> - Determine mercury methylation potential in sediment integrated with depth; <i>Volatile Mercury</i> - Determine if elemental mercury associated with retort on site is trapped in sediments; <i>Dioxins/Furans</i> - Determine if dioxin/furan contamination from Wilson Avenue Property has reached the creek; <i>Mercury by Sequential Extraction ****</i> - Determine which species of mercury are present because certain species are more toxic and can be a concern for direct contact	Mercury vapor and organic vapors (PID)	91
	Middle Creek Section		23								161
	Lower Creek Section		15								105
		Lower Creek Section/Culverted Section	CXX-SE	8	Samples are spaced approximately 500 feet apart in Pierson's Creek because it is a culverted area; samples will determine sediment depth in the culverted section and delineate potential contamination; results will determine if contamination is discharging to Port Newark Basin	Grab sample					8
Air Sampling	Site-wide	TXX-AA	7	Results will determine if elemental mercury trapped in sediments is volatilizing to the air	1 sample at each sediment sampling transect (7 total)	NA	NA	Mercury	Determine if elemental mercury trapped in sediments is volatilizing to the air	Mercury vapor	7
Surface Water Sampling Program											
Surface Water Sampling (Dry Weather)	Upper Creek Section	In Pierson's Creek: TXX-SW-R1; in drainage ditches: DXX-SW-R1	6	Assess baseline transport conditions; delineate contamination of surface water at co-located locations in the creek and its tributaries	48 hours with no precipitation	TCL VOCs, SVOCs, Pesticides, and PCBs; CN, filtered and unfiltered TAL Metals and Hg	TDS, TSS, POC, DOC, chloride, sulfate, phosphate, nitrate, bicarbonate, ammonia and alkalinity	Methylmercury	<i>Methylmercury</i> - Determine the fraction of methylmercury compared to mercury as methylmercury has a higher tendency for biomagnifying through the food-web; <i>DOC and UV 254</i> - Together the results will calculate the aromatic fraction of DOC which is a strong ligand for mercury and methylmercury; <i>Water Quality Parameters</i> - To be used in geochemical modeling	pH, Temp, Cond, DO, Redox Potential, Turbidity, UVA at 254 nm	6
	Middle Creek Section		7								7
	Lower Creek Section		8								8
	Lower Creek Section/Culverted Section	CXX-SW-R1	8								8
	Port Newark Channel Discharge	TXX-SW-R1	2 (TBD)	Determine if contamination from the creek is discharging to the Port Newark Channel							2
	Point and Non-Point Sources	PXX-SW-R1	6	Characterize baseline point and non-point sources of contamination to the creek							6
Surface Water Sampling (Wet Weather)	Upper Creek Section	In transects: TXX-SW-R2; in drainage ditches: DXX-SW-R2	6	Assess contaminant transport under conditions when contaminants will be mobilized from the creek bottom and drainage ditches	Minimum 0.5 inch storm following 48 hours of no precipitation	TCL VOCs, SVOCs, Pesticides, and PCBs; CN, filtered and unfiltered TAL Metals and Hg	TDS, TSS, POC, DOC, chloride, sulfate, phosphate, nitrate, bicarbonate, ammonia and alkalinity	Methylmercury	<i>Methylmercury</i> - Determine the fraction of methylmercury compared to mercury as methylmercury has a higher tendency for biomagnifying through the food-web; <i>DOC and UV 254</i> - Together the results will calculate the aromatic fraction of DOC which is a strong ligand for mercury and methylmercury; <i>Water Quality Parameters</i> - To be used in geochemical modeling	pH, Temp, Cond, DO, Redox Potential, Turbidity, UVA at 254 nm	6
	Middle Creek Section		7								7
	Lower Creek Section		8								8
	Lower Creek Section/Culverted Section	CXX-SW-R2	8								8
	Port Newark Channel Discharge	TXX-SW-R2	2 (TBD)	Determine if contamination from the creek is discharging to the Port Newark Channel							2
	Point and Non-Point Sources	PXX-SW-R2	6	Characterize point and non-point sources of contamination during a rain event							6

Table 1 Sample Summary and Analyses Pierson's Creek Site OU1 Newark, New Jersey											
Field Event	Section	Sampling Identification***	Sampling Locations	Sample Location Rationale	Sampling/Measurement Activities						
					Sampling Frequency / Intervals	Analytical Parameters				Field Parameters	Total Samples*
						CLP Analyses	DESA Analyses	Subcontract Analyses	Analytical Rationale		
Soil Sampling Program											
Soil Sampling	Upper Creek Section	SO-XX	3	Determine if contamination has reached the wetland area east of the northernmost drainage ditch	0 to 0.5, 0.5 to 1.5, 1.5 to 3, 3 to 5 feet	TCL VOCs, SVOCs, Pesticides, and PCBs; TAL Metals, CN, Hg	Grain size, TOC, % solids	Methylmercury	Methylmercury - Determine the mercury methylation potential in soil integrated with depth; Soil Characteristics - To be used in geochemical modeling	Mercury vapor and organic vapors (PID)	12
	Middle Creek Section		10 (15)**	Determine if contamination has reached the wetland areas surrounding the middle creek section of the creek							60
	Lower Creek Section		9	Determine if contamination has reached the wetland areas surrounding the drainage ditches in the lower creek section							36
Groundwater Sampling Program											
Groundwater sampling (Round 1)	Upper Creek Section	TMW-XX-R1	2 existing, 8 new	Determine if contaminated groundwater is discharging to the creek and/or or vice versa; horizontally and vertically delineate groundwater contamination	per well	TCL VOCs, SVOCs, Pesticides, and PCBs; filtered and unfiltered TAL Metals and Hg, CN	TDS, TSS, TOC, DOC, ammonia, chloride, sulfate, phosphate, nitrate, bicarbonate, and alkalinity	NA	Water Quality Parameters - To be used in geochemical modeling	pH, Temp, Cond, DO, Redox Potential, Turbidity	10
	Middle Creek Section		4 existing, 12 new								16
	Lower Creek Section		4 new								4
Groundwater sampling (Round 2)	Upper Creek Section	TMW-XX-R2	2 existing, 8 new		per well	TCL VOCs, SVOCs, Pesticides, and PCBs; filtered and unfiltered TAL Metals and Hg, CN	TDS, TSS, TOC, DOC, ammonia, chloride, sulfate, phosphate, nitrate, bicarbonate, and alkalinity	NA		pH, Temp, Cond, DO, Redox Potential, Turbidity	10
	Middle Creek Section		4 existing, 12 new								16
	Lower Creek Section		4 new								4
Waste Characterization											
Waste Characterization	Site-wide	WC-XX	5	Target each of the five main transects	Composite sample from 0 - 5 feet	TCLP RCRA 8 Metals, Reactivity , SPLP Leachate analzed for RCRA 8 Metals;	NA	Leachability-modified SPLP extraction	Leachability- to be used in calculating impact to groundwater; TCLP RCRA 8 Metals & Reactivity - to estimate costs of disposal during feasibility study	NA	5

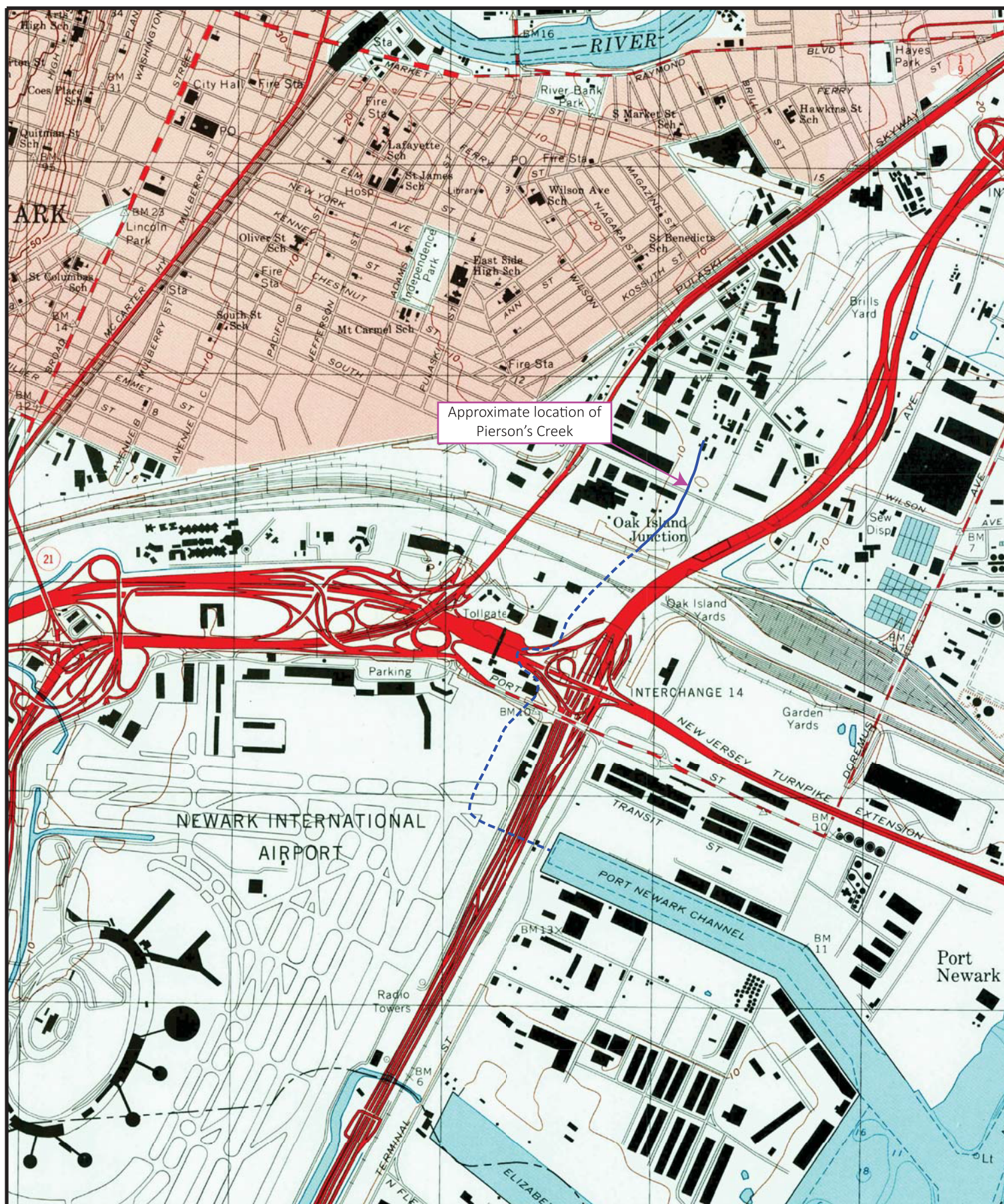
Notes: *Totals do not include QC samples. See WS 20 for QC sample counts.
**Several soil borings will be performed by the property owner's consultant. CDM Smith will manage the data.
***See figures 2 through 5 for locations of all samples.
****For samples analyzed for sequential extraction, Mercury will be analyzed by the subcontract laboratory performing the sequential extraction.

CN - cyanide
Cond - conductivity
DO - dissolved oxygen
DOC - dissolved organic carbon
Hg - mercury
NM - nanometer
PID - photoionization detector
POC - particulate organic carbon
RCRA - Resource Conservation and Recovery act
SPLP - Synthetic Precipitation Leaching Procedure (SPLP) (U.S. EPA Method 1312)
TAL - target analyte list
TAT - turn around time
TCL - target compound list

TOC - total organic carbon
TDS - total dissolved solids
Temp - temperature
TSS - total Suspended solids
TCLP - Toxicity Characteristics Leaching Procedure
UVA - ultraviolet absorbance



Figures



Source: USGS 7.5 Minute Quadrangle Map, Elizabeth, New Jersey

— Aboveground portion of Pierson's Creek
 - - - Underground portion of Pierson's Creek

CDM
Smith

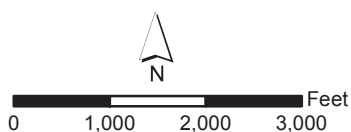


Figure 1
 Site Location Map
 Pierson's Creek Superfund Site
 Newark, NJ



Pierson's Creek Orientation

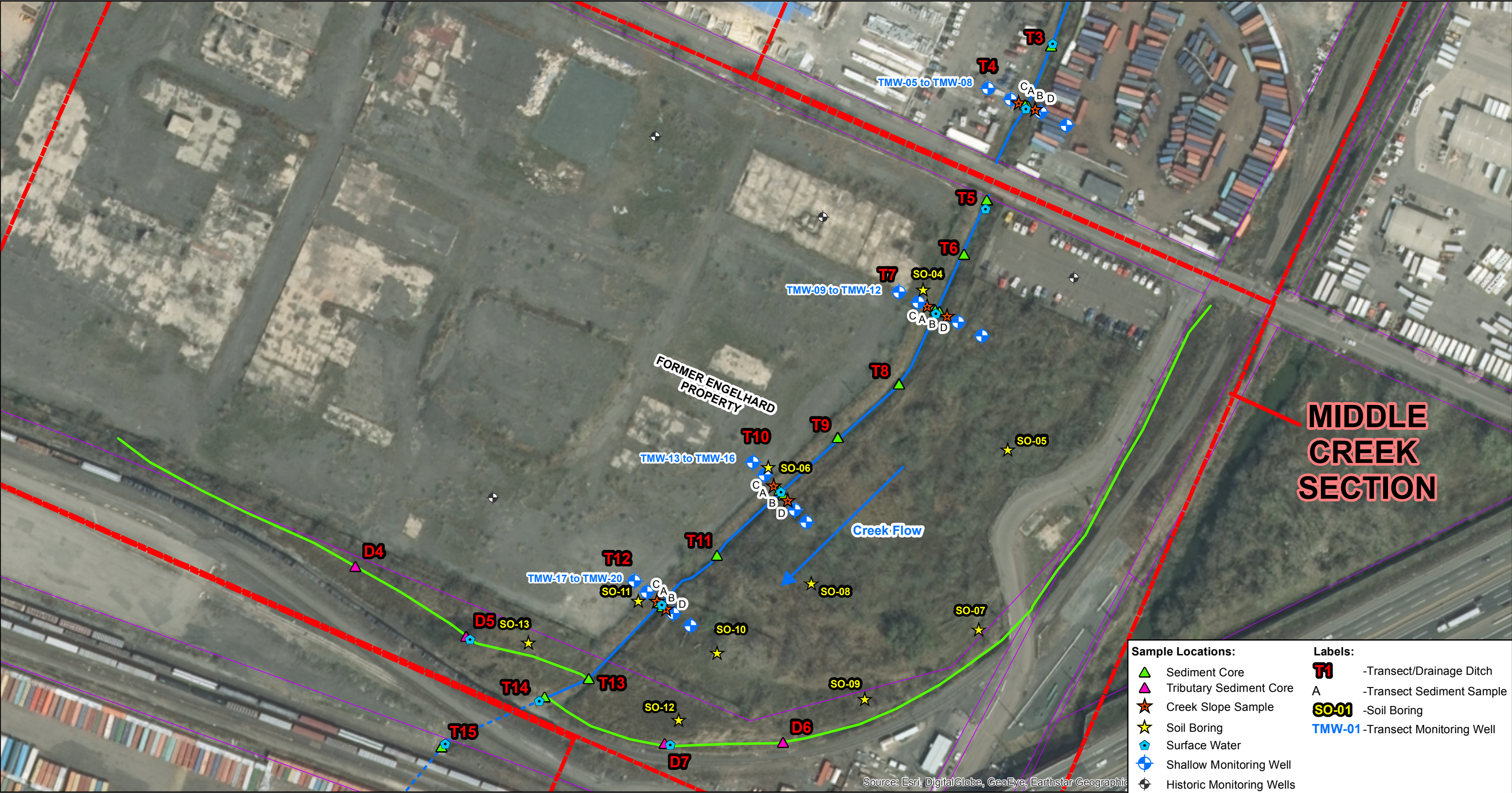
- Current Pierson's Creek Channel (open channel)
- Current Pierson's Creek Channel (culverted)
- Feeder Creeks
- Former Portion of Pierson's Creek
- Creek Sections

Figure 2
Sampling Locations - Upper Creek Section
Pierson's Creek Superfund Site
Newark, NJ

Source: Esri, DigitalAeroGRID, IGN, and others

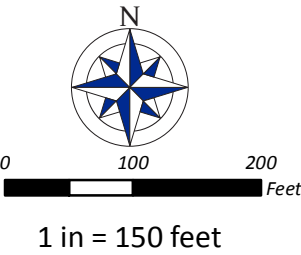
1 in = 100 feet

CDM Smith



Pierson's Creek Orientation

- Current Pierson's Creek Channel (open channel)
- Current Pierson's Creek Channel (culverted)
- Feeder Creeks
- Former Portion of Pierson's Creek
- Creek Sections



Sample Locations:

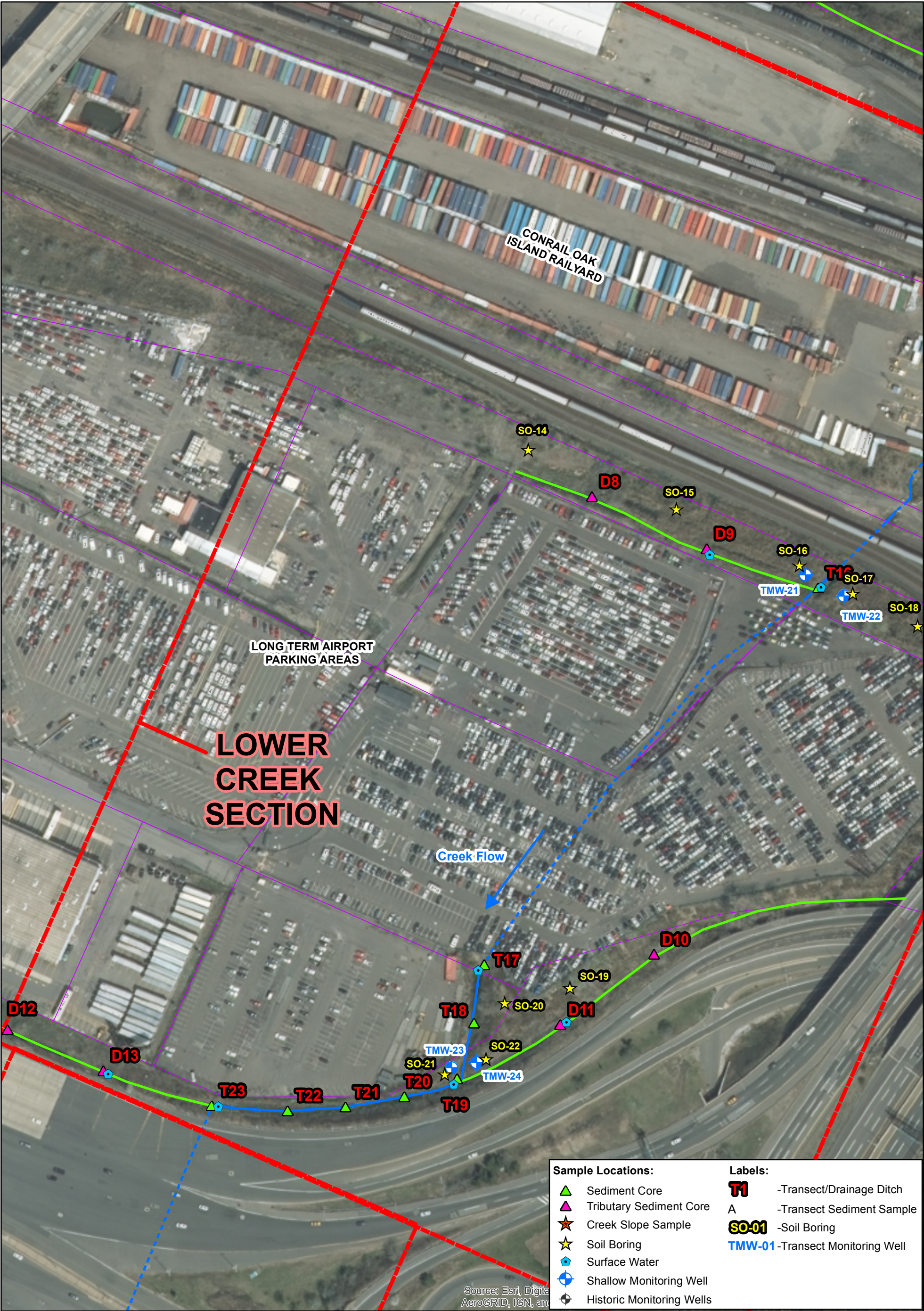
- Sediment Core
- Tributary Sediment Core
- Creek Slope Sample
- Soil Boring
- Surface Water
- Shallow Monitoring Well
- Historic Monitoring Wells

Labels:

- T1** -Transect/Drainage Ditch
- A** -Transect Sediment Sample
- SO-01** -Soil Boring
- TMW-01** -Transect Monitoring Well

Figure 3
Sampling Locations - Middle Creek Section
Pierson's Creek Superfund Site
Newark, NJ





Pierson's Creek Orientation

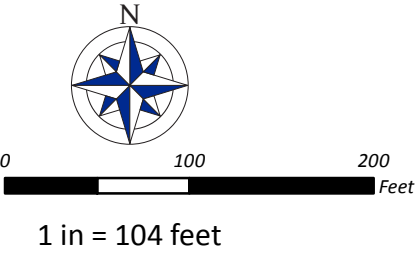
- Current Pierson's Creek Channel (open channel)
- Current Pierson's Creek Channel (culverted)
- Feeder Creeks
- Former Portion of Pierson's Creek
- Creek Sections

Figure 4
Sampling Locations - Lower Creek Section
Pierson's Creek Superfund Site
Newark, NJ

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- Pierson's Creek Orientation**
- Current Pierson's Creek Channel (open channel)
 - Current Pierson's Creek Channel (culverted)
 - Feeder Creeks
 - Former Portion of Pierson's Creek
 - Creek Sections



- | | |
|---------------------------|---|
| Sample Locations: | Labels: |
| Sediment Core | T1 -Transect/Drainage Ditch |
| Tributary Sediment Core | A -Transect Sediment Sample |
| Creek Slope Sample | SO-01 -Soil Boring |
| Soil Boring | TMW-01 -Transect Monitoring Well |
| Surface Water | |
| Shallow Monitoring Well | |
| Historic Monitoring Wells | |

Figure 5
Sampling Locations - Port Newark Channel
Pierson's Creek Superfund Site
Newark, NJ



Appendix A

Appendix A

CDM Smith Technical Standard Operating Procedures (SOPs)

Surface Water Sampling

SOP 1-1

Revision: 10

Date: February 2015

Approved :



Signature

Technical Review:

Curt Coover

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to define requirements for collection and containment of surface water samples.

2.0 Background

Surface water samples are collected to determine the type(s) and level(s) of contamination in a particular surface water body and/or its biological disposition.

2.1 Definitions

Surface Water - Water that flows over or rests on the land and is open to the atmosphere. This includes ditches, streams, rivers, lakes, pools, ponds, and basins.

Shallow Surface Water - Water within 1 to 3.3 feet (0.3 to 1 meter) of the surface of a body of water.

Deep Surface Water - Water deeper than 3.3 feet (1 meter) of the surface of a body of water.

Grab Sample - A discrete portion or aliquot taken from a specific location at a given point in time.

Simple Composite - Two or more subsamples taken from a specific media and site at a specific point in time. The subsamples are collected and mixed, and then a single average sample is taken from the mixture.

Temporal Composite - Two or more subsamples taken from a specific media and site over a period of time. The subsamples are collected and mixed, and then a single average sample is taken from the mixture.

Churn Splitter - Large vessel for compositing subsamples. Includes a mechanism to agitate the water to keep solids suspended.

2.2 Associated Procedures

- SOP 1-2, *Sample Custody*
- SOP 2-1, *Packaging and Shipping Environmental Samples*
- SOP 4-1, *Field Logbook Content and Control*
- SOP 4-2, *Photographic Documentation of Field Activities*
- SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this SOP, related SOPs, and the required equipment.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The FTL also must ensure that the quantity and location of surface water samples collected meet the requirements of the site-specific plans.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

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4.0 Required Equipment

All or part of the equipment listed under the “as needed” category may be required at any specific site, depending on the plan(s) for that site.

- Site-specific plans
- Field logbook
- Indelible black-ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler and waterproof sealing tape
- Ice bags or “blue ice”
- Plastic zip-top bags
- Clear waterproof tape
- Personal protective clothing and equipment
- Latex or appropriate gloves
- Rubber boots and/or rubberized waders
- Life jacket
- Kimwipe or paper towels
- Clean plastic sheeting
- Tap and deionized water
- Appropriate photographic equipment and supplies
- Appropriate decontamination equipment and supplies

As needed:

- Pond sampler with 1-liter (L) beaker (preferably Teflon®), clamp, and heavy-duty telescoping pole
- Weighted bottle sampler, 1-L capacity (preferably Teflon) and handle; see USGS Open File Report 2005-1087 for selection of sampler; a Kemmerer or Van Dorn sampler may be used if Teflon is not required
- Churn splitter
- Peristaltic pump or suitable replacement
- Temperature, pH, and conductivity meter(s), dissolved oxygen meter, redox potential meter (as required by project plan)
- Boat with depth finder for deep water or inaccessible shorelines
- Global positioning system (GPS) unit
- Tape measure
- Any personal protective equipment specified in the site-specific health and safety plan
- Spare parts for all equipment

5.0 Procedures

5.1 Preparation

The following steps should be taken when preparing for sampling surface water:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.
3. Select wadeable stream/river sampling locations that exhibit cross-sectional homogeneity and are well-mixed. Avoid areas where the channel is constricted or bends where scouring may have occurred. For lake samples, the investigator should consider the lake stratification caused by seasonal temperature differences. If possible, select a location that can be described precisely, such as xx feet upstream of xx bridge. Use caution when wading streams more than 1 to 2 feet deep. Flowing water can be a safety hazard.
4. Prepare sampling site by laying out clean plastic sheeting on the ground or any flat, level surfaces near the sampling area and place equipment to be used on the plastic.
5. Make field measurements as required by the project plans in physical, chemical, and biological characteristics of the water (e.g., discharge, gage height, temperature, dissolved oxygen, conductivity, pH).

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6. The samples shall be collected from areas of least to greatest contamination (when known) and, when collecting several samples in 1 day, always collect from downstream to upstream.
7. The sampler should be facing upstream when sampling, both for proper sample collection and for safety (ability to observe floating objects).
8. Document the sampling events, recording all information in the designated field logbook and take photographs if required or if possible. Document any and all deviations from this SOP and include rationale for changes.
9. The collection points shall be located on a site map and described in the field logbook. Use GPS if required or if possible.
10. Label each sample container with the appropriate information. Secure the label by covering it with a piece of waterproof clear tape.
11. Decontaminate reusable sampling equipment after sample collection according to SOP 4-5.
12. Processes for verifying depth of samples must be included in site-specific project plans.
13. Check that a trip blank/temperature blank, when necessary, is included in the chilled cooler. Quality assurance/quality control sample requirements vary from project to project. Consult the project-specific work plan for quality requirements.

5.2 Shallow Surface Water Sample Collection for Wadeable Streams**5.2.1 Method for Collecting Samples for Volatile Organic Compound Analysis**

All volatile organic compound (VOC) samples should be discrete samples. The following steps must be taken when collecting shallow surface water VOC samples:

If the volatile organic analysis (VOA) vials do not require a preservative:

1. Approach the sample location from downstream; do not enter the sample area. Slowly submerge VOA vials completely into an area of gently flowing water and fill. Do not disturb bottom sediments. The open end of the vials should be pointed upstream

Note: When collecting samples for VOC analysis, avoid collecting from a surface water point where water is cascading and aerating.

2. Cap the VOA vial while it is underwater. Be sure to dislodge all air bubbles from the cap before sealing the vial.
3. Turn the capped vial upside down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.
4. Proceed to Step 5 below.

If the VOA vials require a preservative:

1. Collect a sufficient sample in a clean glass jar as in Steps 1 and 2 above for unpreserved vials. Specific sampling devices to be used must be specified in site-specific plans.
2. Decant the sample immediately into prepreserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Tip vials slightly while filling to reduce turbulence until nearly filled. Then straighten vial to vertical for final filling. Ensure that a meniscus is raised above the lip of the vial before capping.
3. Cap each vial once the meniscus has formed.

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4. Turn the capped vial upside down and check for air bubbles. Tap the bottom of the vials to dislodge any bubbles that may have formed around the cap or sides. Discard and resample if bubbles are present.
5. Wipe the outside of sample vials with a Kimwipe or clean paper towel. Affix a completed sample label.
6. Place sample vial(s) in a zip-top plastic bag and seal the bag.
7. Immediately pack all samples into a chilled cooler.

5.2.2 Method for Collecting Discrete Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

The following steps must be followed when collecting discrete shallow surface water samples for nonvolatile organic or inorganic compound analysis:

1. Directly dip the sample container, with the opening facing upstream, into the surface water and fill. If wading is necessary, approach the sample location from downstream; do not enter the actual sample area. Do not disturb underlying sediments.
2. Filter samples if required by the site-specific plan.
3. Add appropriate preservatives to the sample containers if required and check pH.

Note: Use a separate container when field testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

4. Cap the sample containers and wipe the outer surfaces of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
5. Place sample container(s) in individual zip-top plastic bags, if possible, and seal the bags.
6. Immediately pack all samples into a chilled cooler.

5.2.3 Method for Collecting Simple Composite Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

If the QAPP requires the use of simple composite samples, then a sampler capable of collecting composite samples is required. For width and depth integrated (WDI) composite samples, a DH-48 or DH-81 are recommended, but the QAPP may specify an alternative. The following steps must be followed when collecting simple composite shallow surface water samples for nonvolatile organic or inorganic compound analysis:

1. Record the gage height, if any, before and after sampling.
2. Select the number of width increments based on the requirements of the QAPP. Generally, small well mixed streams require few increments while large or poorly mixed streams require more increments.
3. For fewer than six width increments, subsample locations can be visually estimated. For more than five width increments, string a tape measure across the stream above the water surface to be able to accurately identify the subsample locations. Increments should be evenly spaced across the stream for equal width-integrated (EWI) sampling.

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4. If depth-integrated sampling is required, collect a subsample at each width increment by submerging the sampler, orifice facing upstream, from the surface to near the bottom and back up to the surface again in an even steady motion. Do not disturb the sediment at the bottom. The sampler should be retrieved less than full. If the sampler is full, empty it and repeat the subsample collection.
5. If depth-integrated sampling is not required, submerge the sampler with the orifice facing upstream into the surface water and fill.
6. Empty the sampler into a churn splitter or temporary container for later splitting.
7. Repeat Steps 4 to 6 for each width increment.
8. If temporary containers were used, empty into churn splitter. Operate the churn splitter by moving the churn up and down in a steady motion fast enough to homogenize the sample without causing aeration. While the churn is in motion, fill the sample bottles from the tap on the churn.
9. Follow Steps 2 through 6 in Section 5.2.2.

5.2.4 Method for Collecting Temporal Composite Shallow Surface Water Samples for Nonvolatile Organic or Inorganic Compound Analysis

If the QAPP requires the use of temporal composite samples, this can be accomplished using a series of discrete samples collected by hand or an automated sampler, or using a series of simple composite samples. Refer to the preceding sections for collecting the subsamples. The compositing scheme can be time-based (e.g., once per hour for 4 hours) or time-discharge (or time gage height) based (e.g., once per hour until the gage height exceeds xx feet, then change to once per 15 minutes).

Because of the project-specific nature of temporal composite sampling, the specific requirements should be identified in the QAPP. The following are general steps to be followed to collect temporal composite samples:

1. Provide for a method of measuring discharge or gage height before, during, and after sample collection as required in the QAPP.
2. Select the number of time increments based on the requirements of the QAPP. If the time increments change based on a change in flow or water quality, specify the trigger, the new time increment, and any additional trigger to return to the previous increment.
3. Calculate the storage volume for the subsamples and provide a churn splitter of adequate size to contain the entire sample to be composited.
4. Collect the samples according to a method described in this SOP or alternate specified in the QAPP.
5. Provide for cold storage of subsamples, if possible. Do not process any subsamples by filtering or preserving unless specified in the QAPP.
6. Following collection of all subsamples, empty the containers into a churn splitter. If discrete data are required including laboratory or field analysis, retain a portion of the subsample.
7. Operate the churn splitter by moving the churn up and down in a steady motion fast enough to homogenize the sample without causing aeration. While the churn is in motion, fill the sample bottles from the tap on the churn.
8. Follow Steps 2 through 6 in Section 5.2.2.

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9. Field parameters should be measured in the surface water at the time of collection. Some field parameters can be measured on the subsamples at the time of compositing, but the temperature and temperature-dependant parameters will not be representative.

5.3 Deep Surface Water Sample Collection**5.3.1 Method for Collecting Samples at Specified Depth Using a Weighted Bottle Sampler**

The following steps must be followed when collecting surface water samples at specific depths using a weighted bottle sampler:

1. Lower the weighted bottle sampler to the depth specified in the site-specific plan.
2. Remove the stopper by pulling on the sampler line; allow the sampler to fill with water.
3. Release the sampler line to reseal the stopper and retrieve the sampler to the surface.
4. Wipe the weighted bottle sampler dry with a Kimwipe or clean paper towel.
5. Remove the stopper slowly. Fill the specified number of sample containers by slightly tipping the sampler against each sample bottle. Samples to be used for VOC analysis should be decanted directly from the sampler first into prepreserved VOA vials. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Add appropriate preservatives to the other sample containers and check pH. Samples may be pooled in stainless steel, glass, or Teflon containers to obtain the necessary volumes. Filter samples if required. Collect sample in separate container for pH, conductivity, temperature, and other measurements if necessary.
6. Close each sample container with the Teflon-lined cap once it is filled. Check for air bubbles in the VOC sample containers. If bubbles are present, discard and resample.
7. Wipe the outside of the sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
8. Place sample container(s), if possible, in individual zip-top plastic bags, and seal the bags.
9. Immediately pack all samples into a chilled cooler.

5.3.2 Method for Deep Surface Water Sample Collection Using a Peristaltic Pump

The following steps must be followed when collecting deep surface water samples using a peristaltic pump:

1. Install clean medical-grade silicon or Teflon tubing on the pump head. Leave sufficient tubing on the discharge side for convenient dispensing of liquid directly into sample containers.
2. Select the appropriate length of Teflon intake tubing necessary to reach the specified sampling depth. Attach the intake sampling tube to the intake pump tube.
3. Lower the intake tube into the surface water at the specified sampling location to the specified depth; make sure the end of the intake tube does not touch underlying sediments.
4. Start the pump and allow at least three tubing volumes of liquid to flow through and rinse the system before collecting any samples. Do not immediately dispense the purged liquid back to the surface water body. Instead, collect the purged liquid and return it to the source after sample collection is complete.
5. Fill the specified number of sample containers directly from the discharge line. Filter samples if required by the site-specific plan. While filling, allow the liquid to flow gently down the inside of the sample bottle to minimize turbulence.

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For VOC samples, fill prepreserved VOA vials and allow a meniscus to form above the top of the container before capping. It is recommended that the amount of preservative be predetermined on a separate aliquot of sample that is subsequently discarded. Check VOA vials to ensure that there are no air bubbles. Add appropriate preservatives to the other samples and check pH.

Note: Use a separate container when field-testing pH, conductivity, temperature, etc. Do not insert pH paper or probe directly into sample container.

6. Cap the sample container(s). Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
7. Place sample container(s) in individual zip-top plastic bags and seal the bags.
8. Immediately pack all samples into a chilled cooler.
9. Drain the pump system, rinse it with deionized water, and wipe it dry. Replace all tubing with new tubing before sampling at another sampling location. Place all used tubing in plastic bags to be discarded or decontaminated according to the site-specific plans.

6.0 Restrictions/Limitations

Peristaltic pumps are generally not capable of lifting water distances greater than 20 to 25 feet (6 to 7.5 meters) above the normal hydrostatic level.

Grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point and has been disturbed.

7.0 References

_____. Region 4. *Operating Procedure, Surface Water Sampling*, Science and Ecosystem Support Division. February 28, 2013 or current revision.

U. S. Geological Survey. *National Field Manual for the Collection of Water-Quality Data, Chapter A4*. Version 2.0 September 2006.

_____. A Guide to the Proper Selection and Use of Federally Approved Sediment and Water Quality Samplers. Open-File Report 2005-1087. 2005.

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Approved:



Signature

Technical Review:

Scott Kirchner

1.0 Objective

Because of the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures are followed. All paperwork associated with the sample custody procedures will be retained in CDM Smith files unless the client requests that it be transferred to them for use in legal proceedings or at the completion of the contract.

Note: Sample custody documentation requirements vary with the specific EPA region or client. This technical standard operating procedure (SOP) is intended to present basic sample custody requirements, along with common options. Specific sample custody requirements shall be presented in the project-specific quality assurance (QA) project plan or project-specific modification or clarification form (see Section U-1).

2.0 Background**2.1 Definitions**

Sample - A sample is material to be analyzed that is contained in single or multiple containers representing a unique sample identification number.

Sample Custody - A sample is under custody if:

1. It is in your possession
2. It is in your view, after being in your possession
3. It was in your possession and you locked it up
4. It is in a designated secure area

Chain-of-Custody Record - A chain-of-custody record is a form used to document the transfer of custody of samples from one individual to another.

Custody Seal - A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping.

Sample Label - A sample label is an adhesive label placed on sample containers to designate a sample identification number and other sampling information.

Sample Tag - A sample tag is attached with string to a sample container to designate a sample identification number and other sampling information. Tags may be used when it is difficult to physically place adhesive labels on the container (e.g., in the case of small air sampling tubes). Check with your EPA regional Contract Laboratory Program (CLP) coordinator as not all Regions require sample tags.

3.0 General Responsibilities

Sampler - The sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events. The FTL is also responsible for coordinating with the subcontractor laboratory to ensure that adequate information is recorded on custody records. The FTL determines whether proper custody procedures were followed during the fieldwork.

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Field Sample Custodian - The field sample custodian, when designated by the FTL, is responsible for accepting custody of samples from the sampler(s) and properly packing and shipping the samples to the laboratory assigned to do the analyses. A field sample custodian is typically designated only for large and complex field efforts.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Supplies

- Chain-of-custody records (applicable client or CDM Smith forms)
- Sample labels and/or tags
- Scribe software (if required)
- Custody seals
- Clear tape
- Computer
- Printer and paper

5.0 Procedures

5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a chain-of-custody record. This procedure will be followed for all samples collected or split samples accepted.

Field Custody

1. Collect only the number of samples needed to represent the media being sampled. To the extent possible, determine the quantity and types of samples and sample locations before the actual fieldwork. As few people as possible shall handle samples.
2. Complete sample labels or tags for each sample using waterproof ink.
3. Maintain personal custody of the samples (in your possession) at all times until custody is transferred for sample shipment or directly to the analytical laboratory.

Transfer of Custody and Shipment

1. Complete a chain-of-custody record for all samples (see Figure 1 for an example of a chain-of-custody record. Similar forms may be used when requested by the client). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the sample custodian in the appropriate laboratory.
 - The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the chain-of-custody record.
 - In all cases, it must be readily apparent that the person who received custody is the same person who relinquished custody to the next custodian.
 - If samples are left unattended or a person refuses to sign, this must be documented and explained on the chain-of-custody record.

Note: If a field sample custodian has been designated, he/she may initiate the chain-of-custody record, sign, and date as the relinquisher. The individual sampler(s) must sign in the appropriate block, but does (do) not need to sign and date as a relinquisher (refer to Figure 1).

2. Package samples properly for shipment and dispatch to the appropriate laboratory for analysis. Each shipment must be accompanied by a separate chain-of-custody record. If a shipment consists of multiple coolers, a chain-of-custody record shall be filled out for each cooler documenting only samples contained in that particular cooler.

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3. The original record will accompany the shipment, and the copies will be retained by the FTL and, if applicable, distributed to the appropriate sample coordinators. Freight bills will also be retained by the FTL as part of the permanent documentation. The shipping number from the freight bill shall be recorded on the applicable chain-of-custody record and field logbook in accordance with SOP 4-1, Field Logbook Content and Control.

Procedure for Completing CDM Smith Example Chain-of-Custody Record

The following procedure is to be used to fill out the CDM Smith chain-of-custody record. The record provided herein (Figure 1) is an example chain-of-custody record. If another type of custody record (i.e., provided by the EPA Contract Laboratory Program (CLP) or a subcontract laboratory or generated by Scribe) is used to track the custody of samples, the custody record shall be filled out in its entirety.

1. Record project number.
2. Record FTL for the project (if a field sample custodian has been designated, also record this name in the "Remarks" box).
3. Record the name and address of the laboratory to which samples are being shipped.
4. Enter the project name/location or code number.
5. Record overnight courier's airbill number.
6. Record sample location number.
7. Record sample number.
8. Note preservatives added to the sample.
9. Note media type (matrix) of the sample.
10. Note sample type (grab or composite).
11. Enter date of sample collection.
12. Enter time of sample collection in military time (24 hour clock).
13. When required by the client, enter the names or initials of the samplers next to the sample location number of the sample they collected.
14. List parameters for analysis and the number of containers submitted for each analysis.
15. Enter appropriate designation for laboratory quality control (e.g., matrix spike/matrix spike duplicate [MS/MSD], matrix spike/duplicate [MS/D]), or other remarks (e.g., sample depth).
16. Sign the chain-of-custody record(s) in the space provided. All samplers must sign each record.
17. If sample tags are used, record the sample tag number in the "Remarks" column.
18. The originator checks information entered in Items 1 through 16 and then signs the top left "Relinquished by" box, prints his/her name, and enters the current date and time (military).
19. Send the top two copies (usually white and yellow) with the samples to the laboratory; retain the third copy (usually pink) for the project files. Retain additional copies for the project file or distribute as required to the appropriate sample coordinators.
20. The laboratory sample custodian receiving the sample shipment checks the sample label information against the chain-of-custody record. Sample condition is checked and anything unusual is noted under "Remarks" on the chain-of-custody record. The laboratory custodian receiving custody signs in the adjacent "Received by" box and keeps the copy. The white copy is returned to CDM Smith.

5.2 Sample Labels and Tags

Unless the client directs otherwise, sample labels or tags will be used for all samples collected or accepted for CDM Smith projects.

1. Complete one label or tag with the information required by the client for each sample container collected. A typical label or tag would be completed as follows (see Figure 2 for example of sample tag; labels are completed with the equivalent information):
 - Record the project code (i.e., project or task number).
 - Enter the station number (sample number or EPA CLP identification number) if applicable.
 - Record the date to indicate the month, day, and year of sample collection.
 - Enter the time (military) of sample collection.
 - Place a check to indicate composite or grab sample.

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- Record the station (sample) location.
 - Sign in the space provided.
 - Place a check next to “yes” or “no” to indicate if a preservative was added.
 - Place a check under “Analyses” next to the parameters for which the sample is to be analyzed. If the desired analysis is not listed, write it in the empty slot. Note: Do not write in the box for “laboratory sample number.”
 - Place or write additional relevant information under “Remarks.”
2. Place adhesive labels directly on the sample containers. Place clear tape over the label to protect from moisture.
 3. Securely attach sample tags to the sample bottle if required. On 2.27 liter (80 oz.) amber bottles, the tag string may be looped through the ring-style handle and tied. On all other containers, it is recommended that the string be looped around the neck of the bottle, then twisted, and relooped around the neck until the slack in the string is removed. In some instances, when the tag cannot be physically attached to the sample container, it is acceptable to simply place the sample tag in the zip lock bag with a sample container.
 4. Double-check that the information recorded on the sample label or tag is consistent with the information recorded on the chain-of-custody record.

5.3 Custody Seals

Two custody seals must be placed on opposite corners of all shipping containers (e.g., cooler) before shipment. The seals shall be signed and dated by the shipper.

Custody seals may also be required to be placed on individual sample bottles. Check with the client or refer to EPA regional guidelines for direction. In these instances the custody seal is placed over or in some cases around the lid or cap of the sample container.

5.4 Sample Shipping

SOP 2-1, *Packaging and Shipping Environmental Samples* defines the requirements for packaging and shipping environmental samples.

6.0 Restrictions/Limitations

Check with the EPA region or client for specific guidelines. If no specific guidelines are identified, this procedure shall be followed.

For EPA CLP sampling events, combined chain-of-custody/traffic report forms generated with Scribe or other EPA-specific records may be used. Refer to regional guidelines for completing these forms.

The EPA Scribe software may be used to customize sample labels and custody records when directed by the client or the CDM Smith project manager.

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7.0 References

U. S. Army Corps of Engineers. 2001 or current revision. *Requirements for the Preparation of Sampling and Analysis Plan*, EM 200-1-3. Appendix F. February.

U. S. Environmental Protection Agency. Revised March 1992 or current revision. *National Enforcement Investigations Center, Multi-Media Investigation Manual*, EPA-330/9-89-003-R. p.85.

_____. 2015. Scribe Manuals. http://www.ertsupport.org/scribe_home.htm and <http://www.epaossc.org/scribe>

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Figure 1
Example CDM Smith Chain-of-Custody Record

125 Maiden Lane, 5th Floor New York, NY 10038 (212) 785-9123 Fax: (212) 785-6114				CHAIN OF CUSTODY RECORD																																			
PROJECT ID.		FIELD TEAM LEADER		LABORATORY AND ADDRESS			DATE SHIPPED																																
PROJECT NAME/LOCATION				LAB CONTRACT:			AIRBILL NO.																																
MEDIA TYPE 1. Surface Water 2. Groundwater 3. Leachate 4. Field QC 5. Soil/Sediment 6. Oil 7. Waste 8. Other _____		PRESERVATIVES 1. HCl, pH <2 2. HNO ₃ , pH <2 3. NaOH, pH >12 4. H ₂ SO ₄ , pH <2 5. Zinc Acetate, pH >9 6. Ice Only 7. Not Preserved 8. Other _____		SAMPLE TYPE G = Grab C = Composite		ANALYSES (List no. of containers submitted)																																	
SAMPLE LOCATION NO.		LABORATORY SAMPLE NUMBER	PRESERVATIVES ADDED	MEDIA TYPE	SAMPLE TYPE			20__	TIME SAMPLED																														
1.																																							
2.																																							
3.																																							
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DISTRIBUTION: White and yellow copies accompany sample shipment to laboratory; yellow copy retained by laboratory; Pink copy retained by samplers.

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Note: If requested by the client, different chain-of-custody records may be used. Copies of the template for this record may be obtained from the Chantilly Graphics Department.

Project Code	Station No.	Month/Day/Year	Time	Designation	Grab	Preservative: Yes <input type="checkbox"/> No <input type="checkbox"/>	
						ANALYSES	
						BOD	Anions
						Solids	(TSS) (TDS) (SS)
						COD, TOC, Nutrients	
						Phenolics	
						Mercury	
						Metals	
						Cyanide	
						Oil and Grease	
						Organics GC/MS	
						Priority Pollutants	
						Volatile Organics	
						Pesticides	
						Mutagenicity	
						Bacteriology	
						Remarks:	
Tag No.		Lab Sample No.					

Note: Equivalent sample labels or tags may be used.

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Approved:



Signature

Technical Review:

David Schroeder

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to define the techniques and requirements for collecting soil samples for environmental or geotechnical characterization purposes from the unconsolidated subsurface zone. General techniques discussed in this SOP include use of hand augers, split-barrel samplers, Shelby tubes, direct-push rig samplers, and backhoes, as well as field sampling and preservation methods.

2.0 Background**2.1 Definitions**

Auger Flight - A steel section length attached to the auger length to extend the augers and remove additional unconsolidated material as drilling depth increases.

Backhoe - An excavator to which a shovel bucket is attached to a hinged boom and is drawn backward to move materials.

Direct Push Rig Sampler - A sampler with a locking tip that keeps the device closed during the sampling push. The tip is released at the desired depth, and the push is continued. During the push, the soil is pushed up into the sampler.

Grab Sample - A discrete portion or aliquot of material taken from a specific location at a given point in time.

Hand Auger - A stainless steel cylinder (bucket) approximately 7 to 10 centimeters (cm), or 3 to 4 inches (in) in diameter and 30 cm, or 1 foot (ft) in length, open at both ends with the bottom edge designed to advance perpendicular to the ground surface with a twisting motion into unconsolidated subsurface material to obtain a soil sample. The auger has a T-shaped handle (used for manual operation) attached to the top of the bucket by extendable stainless steel rods.

Liner - A cylindrical sleeve generally made of brass, stainless steel, or Teflon® that is placed inside a split-barrel sampler, direct-push rig sampler, or hand auger bucket to collect samples for Volatile Organic Compound (VOC) or other analyses or to prevent sample contamination.

Shelby Tube - A cylindrical sampling device which is generally made of steel, and which is driven into the subsurface soil through a hollow-stem auger using a drill rig. The tube, once retrieved, is capped on both ends. The undisturbed soil sample is extruded in the laboratory before soil analysis.

Slide Hammer - A device consisting of a drive weight (hammer) and a drive weight fall guide.

Split-Barrel Sampler - A cylindrical sampling device generally made of carbon steel that fits into a hollow-stem auger. The sampler is opened lengthwise, which allows the sample to be retrieved by “splitting” the barrel sampler. Also referred to as a split-spoon.

Subsurface Soil - The unconsolidated, or non-lithified, material that exists deeper than approximately 30 cm (1 foot) below the ground surface (bgs).

Unconsolidated Zone - A layer of non-lithified earth material (soil or sediment) that has no mineral cement or matrix binding its grains.

2.2 Associated Procedures

- SOP 1-2, *Sample Custody*
- SOP 1-3, *Surface Soil Sampling*

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- SOP 2-1, *Packaging and Shipping Environmental Samples*
- SOP 3-5, *Lithologic Logging*
- SOP 4-1, *Field Logbook Content and Control*
- SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

Shallow subsurface soil samples, or those taken from depths between 0.15 cm to 3 meters (m), or between 6 in and 10 ft bgs, may be collected using hand augers. However, soil samples collected with a hand auger are commonly of poorer quality than those samples collected by split-barrel or Shelby tube samplers because the soil sample is disturbed during the augering process. Split-barrel and Shelby tube samplers are generally used during collection of soil samples using hollow-stem auger drilling methods. Barrel-type samplers may also be used to collect soil samples from hand auger borings using a slide hammer device. For environmental sampling programs, liners are used to minimize the loss of volatile organic compounds (VOCs) and to prevent sample cross-contamination. Collecting samples using a backhoe enables the collector to correlate the precise vertical and horizontal interval of the sample collected relative to adjacent, visible subsurface materials.

The size and material of sampling devices used shall be selected based on project and analytical objectives and as defined in the site-specific sampling and/or work plans. Note that operation and collection of samples via drill rig (split spoon or Shelby tubes), direct-push methods, or backhoe is typically performed by subconsultants to CDM Smith, with field oversight provided by a CDM Smith field representative (engineer, geologist, scientist, or similar) as further discussed in Section 5.2 of this SOP.

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and the required equipment, and for ensuring that subsurface soil samples are collected in accordance with this procedure and any other SOPs pertaining to specific media sampling. The site manager must also ensure that the quantity and location of subsurface soil samples collected meet the requirements of the site-specific sampling and/or work plans.

Field Team Leader - The field team leader is responsible for ensuring that field personnel collect subsurface soil samples in accordance with this SOP and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.0 Required Equipment

4.1 General

- | | |
|--|---|
| ▪ Site-specific plans (e.g., sampling, work, health and safety) | ▪ Plastic zip-top bags |
| ▪ Field logbook | ▪ Personal protective clothing and equipment |
| ▪ Indelible black ink pens and markers | ▪ Plastic sheeting |
| ▪ Clear, waterproof tape | ▪ Stainless steel and/or Teflon-lined spatulas and pans, trays, bowls, trowels, or spoons |
| ▪ Appropriate sample containers | ▪ Decontamination supplies |
| ▪ Labels and appropriate forms/documentation for sample shipment | ▪ Sample chain-of-custody forms |
| ▪ Insulated cooler(s) and waterproof sealing tape | ▪ Custody seals |
| ▪ Bags of ice or “blue ice” packs | ▪ Kimwipes or paper towels |
| ▪ Nitrile or appropriate gloves | |

Additional equipment is discussed in Section 5.2.7, Field Sampling/Preservation Methods.

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4.2 Manual (Hand) Augering

- T-handle
- Hand auger: flighted-, bucket-, or tube-type auger as required by the site-specific plans
- Extension rods
- Wrench(es), pliers
- Slide hammer with extension rods

4.3 Split-Barrel and Shelby Tube Sampling

- Drill rig equipped with a 63-kilogram (kg) (140-lb) drop hammer and sufficient hollow-stem auger flights to drill to the depths required by the site-specific work/sampling plans.
- Sufficient numbers of split-barrel samplers so that at least one sampler is always decontaminated and available for sampling. Three split-barrel samplers are generally the minimum necessary (Shelby tubes are used only once).
- Split-barrel liners (as appropriate).
- Wrench(es), hammer.

4.4 Direct Push Rig Sampling

- Direct push rig with sufficient probe rods to extend to sample depths required by the site-specific work/sampling plans
- Sufficient number of samplers (in case of malfunction) and appropriate liners to collect adequate number of samples
- Extension rods
- Wrench(es), pliers, other specific tools

4.5 Backhoe Sampling

- Backhoe with a sufficient length boom to extend to planned depths
- Sufficient number of trowels or scoops
- Extension rods
- Tape, utility knife, other specific tools as needed

5.0 Procedures

5.1 Preparation

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don the appropriate personal protective clothing as indicated in the site-specific health and safety plan.
3. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc.
4. Processes for verifying depth of sampling must be specified in the site-specific plans.
5. Clear away vegetation and debris from the ground surface at the boring location.
6. If decontamination of equipment and/or personnel is required, set up a decontamination zone in accordance with SOP 4-5.
7. Prepare an area near the sampling location to perform sample collection activities by placing plastic sheeting on the ground, or, if required by the site-specific health and safety plan and or work/sampling plans, place plastic sheeting over the area immediately surrounding the borehole, as applicable.. Sample collection should be performed at a safe distance from all heavy equipment, or as determined by heavy equipment operator(s) and/or the CDM Smith field representative.

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5.2 Sample Collection

The following general steps must be followed when collecting all subsurface soil samples. Refer to section 5.3 of this SOP and SOP 1-3 (Surface Soil Sampling) for additional guidance on field sampling and preservation methods.

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. VOC samples or samples that may be degraded by aeration shall be collected first and with the least disturbance possible. When sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and consequently minimize analyte loss. The representativeness of a VOC grab sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed. Sample containers containing samples for VOC analysis shall be filled completely to minimize headspace (see section 5.3 of this SOP).
3. All sampling information, including environmental and/or geotechnical soil characterization, sample depth, sample volume, and requisite geotechnical or environmental analyses shall be recorded in the field logbook and on any associated forms as specified in the site-specific sampling/work plans. Sample lithology shall be described according to SOP 3-5.
4. Specific sampling devices to be used shall be identified in the site-specific work/sampling plans and shall be recorded in the field logbook.
5. Care must be taken to prevent cross-contamination and misidentification of samples as described in subsequent subsections of this SOP.

5.2.1 Manual (Hand) Augering

The following steps must be followed when collecting environmental soil samples using hand-auger techniques:

1. Advance the auger to the depth specified in the site-specific sampling plan for sample collection. Place cuttings on plastic sheeting or as specified in the site-specific work/sampling plans. If possible, lay out the cuttings in stratigraphic order, or from the shallowest cuttings collected to the deepest cuttings collected.
2. During auger advancement and sample collection, record observations made of the geologic features of the soil or sediments per American Society for Testing and Materials (ASTM) D 2448 (Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) in the field logbook.
3. Stop advancing the auger when the top of the specified sampling depth has been reached. If required by the site-specific sampling plan, remove the auger from the hole and decontaminate the auger or use a separate decontaminated auger, then obtain the sample.
4. Collect a grab sample for VOC analyses (or samples that may be degraded by aeration) immediately and place in sample container. Sample container(s) shall be filled completely to minimize headspace.
5. Remaining sample material for other analyses shall be homogenized before placing samples in the appropriate containers.
6. Wipe container(s) with a clean Kimwipe or paper towel to remove residual soil from the exterior of the container(s).
7. Label the sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.
8. Place the containers in zip-top plastic bags and seal the bags. Pack samples in a cooler with ice or cold packs (to maintain a temperature of 4°C).

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9. Proceed with additional sampling as required by the site-specific plans.
10. When sample collection is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.
11. Complete the field logbook entry and other appropriate forms, being sure to record all relevant information before leaving the site.
12. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. Refer to SOPs 1-2 and 2-1 and site-specific plans.

5.2.2 Manual (Hand) Augering Using a Tube Sampler with Liner or Slide Hammer

The following steps must be followed when collecting environmental soil samples using a hand-auger and a tube sampler with liner or slide hammer:

1. Auger to the depth required for sampling. Place cuttings on the plastic sheeting as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.
2. During auger advancement and sample collection, record observations made of the geologic features of the soil or sediments per ASTM D 2448 (Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) in the field logbook.
3. Stop advancing the auger when the top of the specified sampling depth has been reached. If required by the site-specific sampling plan, remove the auger from the hole and decontaminate the auger per the site-specific work/sampling plan (see line item 11 below).
4. Prepare a clean, new tube sampler by installing a decontaminated liner in the auger tube.
5. Obtain the sample by driving the sample tube through the sample interval with the slide hammer. Remove the liner from the tube and immediately cover the ends with Teflon tape and cap the ends of the tube. Seal the caps with waterproof tape.
6. Wipe sealed liners with a clean Kimwipe or paper towel.
7. Label the sealed liners as required in the site-specific plans. Mark the top and bottom of the sample on the outside of the liner.
8. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a cooler with ice or cold packs (to maintain a temperature of 4°C).
9. Proceed with additional sample collection as required by the site-specific sampling plans.
10. When sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific work/sampling plans.
11. Decontaminate all equipment according to SOP 4-5 between each sample.
12. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.
13. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See SOPs 1-2 and 2-1 or site-specific plans.

5.2.3 Split-Barrel Sampling

Note: Steps 1 through 12 describe the general activities to be performed by a licensed drilling contractor, not by CDM Smith personnel.

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The following steps must be followed when collecting split-barrel samples for environmental and/or geotechnical purposes:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location before drilling, per SOP 4-5 or the site-specific decontamination procedures.
3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s) to the drill rig.
4. Begin drilling and proceed to the first designated sample depth, adding auger flights as necessary.
5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods, if applicable.
7. If required by the site-specific sampling plan, install decontaminated liners in the split barrel sampler.
8. Install a decontaminated split-barrel on the center rod(s) and insert it into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
9. Mark the center rod in 15-cm (6-inch) increments from the top of the auger(s).
10. Drive the split-barrel using the hammer. Use a full 76-cm (30-inch) drop as specified by ASTM D 1586. Record the number of blows required to drive the sampler through each 15-cm (6-inch) increment.
11. Stop driving the split-barrel sampler when the full length of the spoon (24 inches) has been driven or if refusal is encountered. Refusal occurs when little or no progress is made for 50 blows of the hammer. ASTM D1586-11 § 7.2.1 and 7.2.2 defines "refusal" as >50 blows per 6-inches advanced or a total of 100 blows.
12. Pull the sampler free by using upswings of the hammer to loosen the sampler. Pull out the center rod and sampler.
13. Unscrew the sampler assembly from the center rod and place the sampler on the plastic sheeting.
14. Remove the drive shoe and head assembly. If necessary, tap the sampler assembly with a hammer to loosen threaded couplings.
15. With the drive shoe and head assembly off, open (split) the sampler, being careful not to disturb the sample.
16. Label sample containers with appropriate information. Secure the label, covering it with a piece of clear tape. If liners were used, immediately install Teflon tape over the ends of the liners, cap the liners, and seal the caps over the ends of the liner with waterproof tape. Label the samples as required by the site-specific plans. Mark the top and bottom of each sample on the outside of each liner. Indicate boring/well number and depth on the outside of the liner, as required.
17. If samples are to be collected from the soil sample for VOC analyses and liners were not used, place sample material in the appropriate sample container immediately after opening the split-barrel, filling the sample bottle as completely as possible to minimize headspace. Seal the container immediately, then describe the sample material in the field logbook and/or associated forms per ASTM D 2488.
18. Remaining sample material shall be homogenized before placing samples in appropriate containers.
19. Record the sample identification number, depth from which the sample was taken, sample recovery and the analyses to be performed on the samples in the field logbook and on the appropriate forms.

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20. Wipe containers with a clean Kimwipe or paper towel. Label sample containers as required when liners are not used.
21. Place containers and/or sealed liners in zip-top plastic bags and seal the bags. Pack samples in a cooler with ice or cold packs (to maintain a temperature of 4°C)
22. In the field logbook and on the boring log, describe sample lithology by observing cuttings and/or the bottom end of the liner.
23. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
24. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.
25. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans. Backfill borehole as specified in project- and /or site-specific work/sampling plans.
26. Decontaminate samplers and other small sampling equipment according to SOP 4-5 before proceeding to other sampling locations.
27. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.
28. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to appropriate personnel. See SOPs 1-2 and 2-1 or site-specific plans.

5.2.4 Shelby Tube Sampling

Note: Steps 1 through 11 describe activities to be performed by a licensed drilling contractor, not by CDM Smith personnel. ASTM D1586-11 provides additional details pertaining to this sampling methodology.

The following steps must be followed when collecting geotechnical samples using Shelby tubes:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location before drilling.
3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s).
4. Begin drilling and proceed to the first designated sample depth, adding auger(s) as necessary.
5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods, if applicable.
7. Attach a head assembly to a decontaminated Shelby tube sampler assembly. Attach the Shelby tube assembly to the center rods.
8. Lower the Shelby tube and center rods into the hollow-stem augers and seat it at the bottom. Be sure to leave 30 inches or more of center rod above the lowest point to the hydraulic piston's extension.
9. Use the rig's hydraulic drive to push the Shelby tube into undisturbed soil. The tube shall be pushed with a slow, steady force. The pressure used by the driller to push the Shelby tube shall be noted in the field logbook.
10. When the Shelby tube has been advanced to its full length or to refusal, back off the hydraulic pistons. Attach a hoisting plug to the upper end of the center rod, slightly twist to break off the sample, and pull the apparatus out of the hole with the rig winch.

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11. Retrieve the Shelby tube to ground surface, detach it from the center rod, and remove the head assembly.
12. Since the typical intent of Shelby tube sampling is for engineering purposes and an undisturbed sample is required, the tube ends shall be sealed immediately. Sealing is accomplished by filling any void space in the tube with melted beeswax, then placing caps on the ends of the tube and taping caps into place. The top and bottom ends of the tube shall be marked and the tube transported to the laboratory in an upright position. ***It is extremely important that the Shelby tube samples are not disturbed in any way (dropped, rolled, subjected to extreme temperatures, etc.).***
13. Wipe sealed tubes with a clean Kimwipe or paper towel.
14. Indicate boring/well number and depth on outside of the tube.
15. Place sealed tubes in zip-top plastic bags, seal bags, and pack samples in a chilled cooler, if applicable.
16. Continue to advance the borehole to the next sampling point. Collect additional samples per the site-specific sampling plan as outlined above.
17. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.
18. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific work/sampling plans. Backfill borehole as specified in project- and /or site-specific work/sampling plans.
19. Complete the field logbook entry, being sure to record all relevant information before leaving the site.
20. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to appropriate personnel. See SOPs 1-2 and 2-1 or site-specific plans.

5.2.5 Direct Push Rig Sampling

Note: Steps 1 through 11 describe activities to be performed by a licensed drilling contractor, not CDM Smith personnel.

The following steps must be followed when collecting environmental samples using a direct push rig sampler:

1. Verify that the direct-push rig has been decontaminated at a separate location before drilling.
2. Attach the properly assembled sampler with appropriate liner to the end of the probe rod.
3. Attach drive cap and probe to the first designated sample depth, adding rod(s) as necessary.
4. Upon reaching the designated sample depth, remove the drive cap to access the inside of the probe rods.
5. Insert extension rods into probe rod; turn extension rod to release tip.
6. Retrieve extension rods, replace drive cap, add additional push rod if required, and push probe rod to the planned sample interval.
7. Attach pull cap and retrieve push rods and sampler.
8. Remove the sampler from the probe rod, and then remove the cutting shoe from the sampler.
9. Once the cutting shoe is removed, the liner containing the sample material can be removed from the sampler. Analytical samples can now be collected by CDM Smith personnel per site-specific plans and per Section 5.2.2 of this SOP.
10. When sample collection is complete, remove the push rig to the heavy equipment decontamination area.

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11. Dispose of excess sample cuttings, plastic sheeting, etc., as specified in the site-specific plans.
12. Complete the field logbook entry, being sure to record all relevant information before leaving the site.
13. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to appropriate personnel. See SOPs 1-2 and 2-1 or site-specific plans.

5.2.6 Backhoe Sampling

Note: Steps 1, 2, 7, and 8 describe activities to be performed by a licensed heavy equipment operator, not CDM Smith personnel.

The following steps must be followed when collecting environmental samples using a backhoe:

1. Verify that the parts of the backhoe that will come in contact with the soil to be sampled have been decontaminated before excavation begins.
2. Excavate to the depth required in the site-specific plans.
3. Use a stainless steel trowel or scoop to obtain the sample material
4. Attach the trowel to a steel rod, wooden handle, or other similar device.
5. Remove the surface layer of soil "smeared" on the trench wall.
6. Replace the trowel with a clean trowel to collect a representative sample.
7. Analytical samples shall be collected by CDM Smith personnel per site-specific plans and per Section 5.2.2 of this SOP.
8. When sample collection is complete in the trench, backfill the trench with the excavated material, as appropriate.
9. Once the trench has been backfilled, move the backhoe to the heavy equipment decontamination area.
10. Dispose of excess sample cuttings, plastic sheeting, etc., as specified in the site-specific plans.
11. Complete the field logbook entry, being sure to record all relevant information before leaving the site.
12. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to appropriate personnel. See SOPs 1-2 and 2-1 or site-specific plans.

5.3 Field Sampling/Preservation Methods

The following three sections contain SW 846 Methods for sampling and field preservation. These methods include EnCore™ Sampler Method for low-level detection limits, EnCore Sampler Method for high-level limits/screening, and methanol preservation. Use of these methods may be required by the governing EPA Region, the client, or if required by the site-specific sampling plan. These methods are very detailed and contain equipment requirements at the beginning of each section.

When collecting soil samples using the EnCore Sampler Method, collection of soil for moisture content analysis is required. Results of this analysis are used to adjust "wet" concentration results to "dry" concentrations to meet analytical method requirements.

Note: Some variations from these methods, (e.g., sample volume) may be required depending on the contracted analytical laboratory.

5.3.1.1 EnCore Sampler Equipment and Collection Requirements for Low-Level Analyses (<200 µg/kg)

The following equipment is required for low-level analysis:

- Three 5 grams (g) samplers

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Note: The sample volume requirements specified are general requirements. Actual sample volume and/or container sizes may vary depending on client or laboratory requirements.

- One 110-milliliter (mL) (4-ounce [oz.]) wide-mouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

The requirements for collecting low level analysis by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Remove sampler and cap from package and attach T-handle to sampler body.
3. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.
4. Extract sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.
5. Push cap on with a twisting motion to secure to the sampler body.
6. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.
7. Fill out sample label and attach to sampler.
8. Repeat procedure for the remaining two samplers.
9. Collect moisture sample in 110-mL (4-oz.) wide-mouth jar using a clean stainless steel spoon or trowel.
10. Store samplers at 4°C, ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.3.1.2 EnCore Sampler Equipment and Collection Requirements for High-Level Analyses ($\geq 200 \mu\text{g/kg}$)

The following equipment is required for high-level analysis:

- One 5-g sampler or one 25-g sampler (the sampler size used will be dependent on client and laboratory requirements)
- One 110-mL (4-oz.) wide-mouth glass jar or applicable container specified for moisture analysis
- One T-handle
- Paper towels

The requirements for collecting high-level analysis by the EnCore Sampler Method are as follows:

1. Wear clean gloves during handling of all sample containers and sampling devices.
2. Remove sample and cap from package and attach T-handle to sampler body.
3. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.
4. Use clean paper toweling to quickly wipe the sampler head so that the cap can be tightly attached.
5. Push cap on with a twisting motion to attach cap.

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6. Fill out a sample label and attach to sampler.
7. Rotate sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.
8. Collect moisture sample in 110-mL (4-oz.) wide-mouth jar or designated container using a clean stainless steel spoon or trowel.
9. Store samplers at 4°C, $\pm 2^\circ\text{C}$. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

Note: Verify requirements for extraction/holding times.

5.3.1.3 Methanol Preservation Equipment and Sampling Requirements for High-Level Analyses ($\geq 200 \mu\text{g/kg}$)

The following equipment is required for methanol preservation sampling:

- One preweighed jar that contains methanol or a preweighed empty jar accompanied with a preweighed vial that contains methanol (laboratory grade)
- One dry weight cup
- Weighing balance that accurately weighs to 0.01 g (with accuracy of ± 0.1 g)
- Set of balance weights used in daily balance calibration
- Latex gloves
- Paper towels
- Cutoff plastic syringe or other coring device to deliver 5 g or 25 g of soil

The requirements for sampling and preservation are as follows:

1. Wear clean gloves during all handling of preweighed vials.
2. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below. (Commercial sources are available which supply pre-preserved and tared vials which eliminates the need to transport and handle larger quantities of methanol and eliminates the need for a precision scale vials with preservative).
3. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil. The 5-g or 25-g size used is dependent on client and laboratory requirements.
4. Carefully wipe the exterior of the collection device with a clean paper towel.
5. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on the client or laboratory requirements.
6. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.
7. Using the paper toweling, remove any soil off of the vial threads and cap the jar.
8. Weigh the jar with the soil in it to the nearest 0.01 g and record the weight on the sample label.
9. Collect dry weight sample using a clean stainless steel spoon or trowel.
10. Store samples at 4°, $\pm 2^\circ\text{C}$.

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11. Ship sample containers with plenty of ice in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON) to the laboratory.

6.0 Restrictions/Limitations

- Basket or spring retainers may be needed for split-barrel sampling in loose, sandy soils.
- A larger-diameter split spoon sampler assembly in addition to the standard split spoon assembly is recommended for all projects on which environmental sample collection from discrete intervals may be required. This enables additional sample material to be recovered in the event the initial split spoon sample does not yield adequate sample material. This method is not recommended for the collection of samples that are to be analyzed for VOCs.
- Shelby tubes are most appropriately used to sample cohesive materials, and may not retain sample material in loose, sandy soils.
- When grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and consequently minimize analyte loss. The representativeness of a VOC grab sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

American Society for Testing and Materials. 2011. *Standard Test Method for Penetration Test (SPT) and Split Barrel Sampling of Soils*. Standard Method D1586-11.

_____. 2000. *Standard Test Method for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes*. Standard Method D1587-08(2012)e1.

U. S. Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Updates I, II, IIA, IIB, III, and IIIA, IIIB, and IVA, IVB). Method 5035 (**Note:** § 6.2.1.8 of this method says samples stored in EnCore™ samplers shall be analyzed within 48 hours or transferred to soil sample vials in the laboratory within 48 hours): December 1996, Revision O, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

_____. 2014. Region 4. *The Field Branches Quality System and Technical Procedures, Soil Sampling*. SESDPROC-300-R3. August.

Groundwater Level Measurement

SOP 1-6

Revision: 9

Date: February 2015

Approved:



Signature

Technical Review:

David Schroeder

1.0 Objective

Groundwater level measurements are fundamental to groundwater and solute transport studies and are conducted during groundwater sampling events to calculate the amount of groundwater to be purged from the well. This technical standard operating procedure (SOP) defines the techniques and requirements for obtaining depth to groundwater (or groundwater level) measurements.

2.0 Background**2.1 Definitions**

Water Level Indicator - A portable device for measuring the depth from a fixed point (which could be below, at, or above the ground surface) to groundwater inside a well, borehole, or other underground opening.

Measurement Point - An easily located and clearly defined mark at the top of a well from which all water level measurements from that particular well are made. The measurement point shall be as permanent as possible to provide consistency in measurements.

Electrical Tape - A graduated plastic tape onto which a water-sensitive electrode is connected that will electronically signal the presence of water (as a result of circuit closure).

Immiscible Fluids - Two or more fluid substances that will not mix and, therefore, will exist together in a layered form. The fluid with the highest density will exist as the bottom layer, the fluid with the lowest density will exist as the top layer, and any other fluid layers will be distributed relative to their respective densities.

Discharge - The removal/release of water from the zone of saturation.

Recharge - The addition of water to the zone of saturation.

Static Water Level - The level of water in a well, borehole, or other underground opening that is not influenced by discharge or recharge.

Well Casing - A steel, stainless steel, or polyvinyl chloride pipe that extends into a borehole and is connected to the well screen or sealed at the bedrock surface in open-hole wells. The upper portion (approximately 3 to 4 feet) of the well casing is normally enclosed by an outer steel protective casing.

Protective Casing - A steel cylinder or square protective sleeve extending approximately 3 to 5 feet into the ground, surrounding the well casing. For flush-mounted wells, the protective casing will extend only high enough so that the well and protective casing can be enclosed by a Christy box or equivalent vault. In above-grade wells, the protective casing will extend above the ground surface approximately 2 to 3 feet. The protective casing protects the well casing.

2.2 Associated Procedures

- SOP 4-1, *Field Logbook Content and Control*
- SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

The most common uses of static water level data are to: determine the elevation of groundwater, the direction of groundwater flow, identify areas of recharge and discharge, evaluate the effects of manmade and natural stresses on the groundwater system, define the hydraulic characteristics of aquifers, and evaluate stream-aquifer relationships. Specific uses for water level data may include:

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- Determining the change in water level due to distribution and rate of regional groundwater withdrawal
- Showing the relationship of groundwater to surface water
- Estimating the amount, source, and area of recharge and discharge
- Determining rate and direction of groundwater movement

Static water level measurements shall be obtained from each well before purging, sampling, or other disturbance of the water table.

3.0 General Responsibilities

Project Manager - The project manager is responsible for ensuring that measurements are conducted in accordance with this procedure and any other SOP pertaining to site activities related to obtaining groundwater level measurements.

Field Team Leader - The field team leader is responsible for ensuring that field personnel obtain water level measurements in accordance with this and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field sampling plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

4.1 General

- | | |
|--|--|
| <ul style="list-style-type: none"> ▪ Site-specific plans ▪ Field logbook ▪ Indelible black ink pens ▪ Permanent felt-tip marker (e.g., Sharpie) ▪ Personal protective equipment | <ul style="list-style-type: none"> ▪ Decontamination equipment and supplies, including rinse bottles and deionized water ▪ Tap water and large beaker or bucket ▪ Water level meter |
|--|--|

4.2 Measuring Devices

The equipment required to obtain water level measurements is dependent on the type of procedure chosen. Measurements may be made with a number of different devices and procedures. Measurements are taken relevant to a permanent measurement point on the well riser.

Electrical tapes are preferred over other devices such as steel tape because of the electrical tape's simplicity and ability to make measurements in a short period of time. Many types of electrical instruments have been devised for measuring water levels; most operate on the principle that a circuit is completed when two electrodes are immersed in water. Examples of electrical tapes that are frequently used include the Slope Indicator Co.[®] and Solinst[®] electronic water level indicators. These instruments are powered by batteries that shall be checked before mobilization to the field.

Electrical tapes are coiled on a hand-cranked reel unit that contains the batteries and a signaling device that indicates when the circuit is closed (i.e., when the probe reaches the water). Electrodes are generally contained in a weighted probe that keeps the tape taut in addition to providing some shielding of the electrodes against false indications as the probe is being lowered into the hole. The electrical tapes are marked with 0.01-foot increments. Caution shall be exercised when using electrical tapes when the water contains elevated amounts of dissolved solids. Under these conditions, the signaling device will remain activated after the probe is removed from the water. When the water being measured contains very low amounts of dissolved solids, it is possible for the probe to extend several inches below the water level before activating the signaling device. Both of these conditions are related to the conductivity of the water and in some cases may be compensated for by the sensitivity control, if the device has this option. In groundwater with high conductivity the sensitivity control may need to be turned down, and in groundwater with low conductivity the sensitivity control may need to be turned up to obtain a proper depth to groundwater measurement.

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5.0 Procedures**5.1 Preparation**

The following steps must be taken when preparing to obtain a water level measurement:

1. Assign a designated field logbook to record all field events and measurements according to SOP 4-1. Document any and all deviations from SOPs and site-specific plans in the field logbook and include rationale for the changes.
2. Always exercise caution to prevent inappropriate or contaminated materials from entering an environmental well.
3. Standing upwind from the well, open the groundwater well. Monitor the well with a photoionization detector, flame ionization detector, or equivalent vapor analyzer as soon as the cap is opened, as dictated by the site-specific health and safety plan.

For comparability, water level measurements shall always be referenced to the same vertical (elevation) datum marker, such as a U. S. Geological Survey (USGS) vertical and horizontal control point monument. The elevations calculated from the measurement of static water levels shall be referenced to mean sea level unless otherwise specified in the site-specific plans.

The measurement point must be as permanent as possible, clearly defined, marked, and easily located. Frequently, the top of the PVC riser is designated as the measurement point. However, since the top of the riser is seldom smooth and horizontal, one particular point on the riser pipe shall be designated and clearly marked. This can be accomplished by marking a point on the top of the riser pipe with a permanent marker. To avoid spilling liquids into the well, paints or other liquid marking materials shall not be used.

5.2 Water Level Measurement Using Electrical Water Level Indicators

The following steps must be followed when taking water level measurements using electrical tapes:

1. Before lowering the probe into the well, the circuitry shall be checked by dipping the probe in tap water and checking to ensure that the signaling device responds to probe submergence. The probe shall then be lowered slowly into the well until contact with the water surface is indicated. The electrical tape reading is made at the measuring point. Take a second and third check reading to verify the measurement before completely withdrawing the tape from the well. All three measurements shall be recorded in the field logbook.
2. Independent electrical tape measurements of static water levels using the tape shall agree within ± 0.01 foot for depths of less than about 200 feet. At greater depths, independent measurements may not be this close. For a depth of about 500 feet, the maximum difference of independent measurement using the same tape shall be within ± 0.1 foot.
3. Decontaminate the electrical tape according to SOP 4-5 before proceeding to the next well to minimize cross contamination.

It may be necessary to check the electrical tape length with a graduated steel tape after the line has been used for a long period of time (at least annually) or after it has been pulled hard in attempting to free the line. Some electrical tapes, especially the single line wire, are subject to becoming permanently stretched.

5.3 Other Water Level Measurement Methods

Although the method cited above (electrical water level indicator) for measuring water levels predominates in the environmental sector, there are a number of other methods available that may be well suited for a particular purpose.

5.3.1 Ultrasonic Method

The ultrasonic method electronically measures the amount of time it takes a sound wave to reach and reflect off the water surface and return to the ground surface. These instruments contain electronic microprocessors, capable of performing this measurement many times each second. The actual depth to water, as calculated by the microprocessor, is an average of many individual readings.

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5.3.2 Pressure Gauge Method

This method, also called the air-line submergence method, uses a pressure gauge and is the preferred method for obtaining water level measurements in pumping wells. An air line constructed of semi-rigid tubing is inserted into the well below the water table. The tube end at the surface is connected to an air tank or compressor and pressure gauge. Filtered air is then forced through the tube and the resultant pressure is read in pounds per square inch (psi). This reading is converted to feet of water in the column and subtracted from the total tube length to give depth to water. Readings are then converted to groundwater elevation. Results are plotted on a field logging form. Calibration records and the exact procedures used must be maintained.

5.3.3 Acoustic Probe Method

The acoustic probe is an electronic device containing two electrodes and a battery-powered transducer. The probe is attached to a tape. The probe is lowered into the well until a sound is detected, indicating the electrodes in the probe have contacted the water surface. This method is similar to the electrical probe method discussed in Section 5.2.

5.3.4 Continuous Recording Method

The measurement of groundwater elevations within pumping or monitoring wells can be accomplished by the use of a mechanical or digital analog computerized continuous recording system and shall be performed according to specifications given by the manufacturer of each unit. In general, when using the mechanical or digital system, the pressure or electrical transducer is lowered into the well until it intersects the water surface. The actual depth to water is then measured by one of the methods described above and used to calibrate the continuous recorder.

The necessary adjustments and preparations are then completed according to the specifications given for each type of continuous recorder. Proper maintenance of continuous recording devices during water level monitoring shall be performed such that continuous, permanent records are developed for the specified period of time. Records shall be stored on mechanical graph paper or on a microprocessor. Frequent calibrations of equipment shall also be made during monitoring periods of long duration in accordance with the manufacturers' specifications.

6.0 Restrictions/Limitations

6.1 Groundwater and Miscible Fluids

Where water is rapidly dripping or flowing into a well, either from the top of the well or from fractures, obtaining an accurate reading may not be possible.

The effect of the water flowing into the well may interfere with an electronic water level measuring device, resulting in a false water level measurement. If water levels must be recorded in wells completed in aquifers that are recharging or discharging, the electronic water level indicator is the preferred measuring device, but shall be used with the awareness of possible false measurements. To minimize the effects of "splashing," a 1-inch pipe (decontaminated for environmental wells) may be lowered into the pumping well into which the water level indicator is then inserted. This will minimize the effect of "splashing" until the probe contacts the groundwater. It will also protect the probe from becoming tangled in pump wiring or well spacers associated with downhole equipment such as submersible pumps.

6.2 Immiscible Fluids

For wells containing immiscible contaminants, the field personnel will need to use special procedures for the measurement of fluid levels. The procedure to follow will depend on whether layers are light immiscibles that form lenses floating on the top of the water table, or dense immiscibles that sink through the aquifer and form lenses over less permeable layers.

In the case of light immiscibles, measurements of immiscible fluid and water levels cannot be accomplished by using normal techniques. A conventional electrical tape often will not respond to nonconducting immiscible fluids.

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Techniques have been specially developed to measure fluid levels in wells containing immiscible fluids, particularly petroleum products. A special paste or gel applied to the end of the steel tape and submerged in the well will show the top of the oil as a wet line and the top of the water as a distinct color change, or an interface probe can be used that will detect the presence of conducting and nonconducting fluids. Thus, if a well is contaminated with low density, nonconducting immiscible fluids such as gasoline, the probe will first detect the surface of the gasoline, but it will not register electrical conduction. However, when the probe is lowered deeper to contact water, it will detect electrical conduction. Normally, a variation in an audible signal indicates the difference between phases.

Both of these methods have disadvantages. They are less effective with heavier and less refined petroleum products because the product tends to stick to the tape or probe, giving a greater product thickness measurement than is present. Paste or gel cannot be used when sampling groundwater for the same constituents present in the paste or gel product.

Note that water levels obtained in this situation are not suitable for determining hydraulic gradients without further interpretation. To use such data for determining hydraulic gradients, the difference in density between the light immiscible phase and water has to be considered.

Measuring fluid levels in wells screened in lenses of dense immiscible fluids resting on a low permeability formation is somewhat easier, provided the immiscible fluid is nonconducting. The top of the dense layer can be identified by simply using an electrical sounder. As an electrical sounder passes from groundwater into the immiscible phase, the detection unit will deactivate because the fluid will no longer conduct electricity. A better method would be to use an interface probe as described above. The variation in the audible signal associated with the detection of differing phase liquids will also allow the user to obtain a groundwater depth and dense immiscible thickness measurement.

7.0 References

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*. EPA/540/P-87/001. December.

_____. 2013. Region 4. The Field Branches Quality System and Technical Procedures, Groundwater Level and Well Depth Measurement. SESDPROC-105-R2. January

Weight, Willis D. and Sonderegger, John L., 2001. *Manual of Applied Hydrogeology*. Lewis Publishing Company. 187-190.

Field Measurement of Total Organic Vapors

SOP 1-10

Revision: 7

Date: February 2015

Approved:



Signature

Technical Review:

Stuart Barden

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to define the techniques and the requirements for the measurement of total organic vapors in the field.

2.0 Background

2.1 Definitions

Photoionization Detector (PID) - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the photoionization of organic vapors.

Flame Ionization Detector (FID) - A portable, hand-held instrument that measures the concentration of gaseous organic compounds through the flame ionization of organic vapors.

2.2 Associated Procedures

- SOP 1-4, *Subsurface Soil Sampling*
- SOP 1-5, *Groundwater Sampling Using Bailers*
- SOP 1-6, *Water Level Measurement*
- SOP 1-8, *Volatile Organic Compound Air Sampling Using USEPA Method TO-15 with SUMMA Canister*
- SOP 1-12 *Low-Stress (Low-Flow) Groundwater Sampling*
- SOP 3-1, *Geoprobe® Sampling*
- SOP 3-5, *Lithologic Logging*
- SOP 4-3, *Well Development and Purging*

2.3 Discussion

The measurement of organic vapors is a required step during numerous field activities. The primary purpose of such measurements is health and safety monitoring to determine if the breathing zone in a work area is acceptable or if personal protective equipment such as a respirator or a supplied air device is necessary for field personnel. At the perimeter of a work area, measurements can be taken as part of a perimeter air monitoring plan to document protection of surrounding community. In addition to health and safety monitoring, total organic vapor measurement is also used in conjunction with sampling activities, including screening subsurface soil samples, soil vapor and indoor air sampling, and groundwater sampling, where measurements are useful for establishing approximate contaminant levels or ranges.

The two types of instruments most commonly used to measure total organic vapors are PIDs and FIDs. Both instruments first ionize the gaseous compound and then measure the response, which is proportional to the concentration.

2.3.1 PID Operation

The PID is preferred when the compound of interest is an aromatic or halogenated volatile organic compound (VOC). The PID ionizes the sampled vapors using an ultraviolet lamp that emits light energy at a specific electron voltage (eV - labeled on the lamp). The ultraviolet lamp produces photons that are absorbed by the sampled vapor molecule. The molecule becomes excited, producing a positively charged ion and emitting an electron. The number of electrons emitted is proportional to the concentration of the sampled gases. Every organic compound has a specific ionization potential in electron volts. The energy emitted by the lamp must be higher than the ionization potential of the compound for the compound to become ionized and emit an electron. If the ionization potential of the compound is higher than the eV of the lamp, there will be no response on the instrument. Therefore, the ionization potential of the known or suspected compounds shall be checked against the energy of the ultraviolet lamp to verify that the energy provided by the lamp is greater. The manufacturer's manual shall be consulted to determine the appropriate ultraviolet lamp to be used for the known or suspected compounds. Additionally, manufacturer's manuals shall be consulted to obtain the appropriate correction factors for known or suspected contaminants.

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Water vapor in the vapor sample can interfere with the PID detector and cause the instrument to stop responding or cause the zero baseline to drift. This can occur using the PID on a rainy day or when sampling headspace samples that have been in the sun. If moisture interference is suspected, the calibration gas shall be used to check the instrument response by inserting the gas as a check sample, not by recalibrating. If the response is lower than the gas level, then the probe and the ionization chamber shall be dried out before reusing the instrument.

The sampling probe shall not be inserted directly into soil samples or dusty areas, as the instrument vacuum will pull dirt into the ionization chamber. Under particularly dirty or dusty conditions, the lamp may become covered with a layer of dust. If dirty conditions are encountered, or if the instrument response seems to have decreased, then the lamp shall be cleaned. The instrument manual provides instructions on how to remove the instrument cover to access the lamp, and how to clean the screen in the ionization chamber and the surface of the lamp.

The instrument manual may provide instruction on use of disposable dust and/or moisture filters for minimizing effects from dust and/or moisture.

The ultraviolet lamp in the PID is sensitive to shock, especially when using the higher eV lamps. Therefore, they shall be handled and transported carefully.

2.3.2 FID Operation

The FID is preferred when sampling for petroleum hydrocarbons and methane (landfill gases). It responds well to aromatic hydrocarbons but is not as convenient to use as the PID. The FID allows measurement of a wide variety of compounds, but in general its sensitivity is not as high as the PID for compounds where the PID is applicable. The FID is virtually unaffected by ambient levels of water vapor.

The FID ionizes the vapor sample by burning it in a hydrogen/air flame, and measuring the response beyond what is caused by the hydrogen alone. This instrument requires a hydrogen supply, contained in a small tank in the instrument. This hydrogen, including the gas in the instrument tank, is considered a flammable gas and appropriate requirements must be adhered to when shipping. The instrument shall be emptied of hydrogen before shipping. Federal Express Hazardous Material shipping manifests must be completed when shipping the gas.

The hydrogen gas in the FID combustion chamber is ignited by pressing a red button on the side of the instrument, which sends electrical current to a small resistance coil igniter in the combustion chamber. This igniter is very sensitive, and if the red button is pressed for longer than 5 seconds, the coil will burn out and the instrument will be unusable unless another igniter is available. If the instrument will not light, check the electrical connections and switches for proper settings. Check that the pump is pumping, and allow fresh air to flow through the combustion chamber for several minutes before lighting. Check to see if the exhaust port of the combustion chamber is dirty.

3.0 Responsibilities

Site Manager - The site manager is responsible for ensuring that field activities are conducted in accordance with this procedure and any other SOPs pertaining to the specific activity.

Field Team Leader - The field team leader is responsible for ensuring that field personnel conduct field activities in accordance with this and other relevant procedures.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

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4.0 Required Equipment

- Site-specific plans (i.e., scope of work)
- Health and safety plan
- Field logbook
- Waterproof black ink pen
- Personal protective clothing and equipment
- Photoionization detector or flame ionization detector
- Calibration gases in a range appropriate for the expected use
- 0.5 liter (16-ounce) or "Mason" type glass jar or Ziploc-type plastic bags
- Hydrogen canister and fill valve and hose (if using FID for a period of more than 1 day)

5.0 Procedures**5.1 Direct Reading Measurement**

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, etc.) as outlined in the manufacturer's manual.
2. Calibrate the instrument following the applicable manufacturer's manual
3. Make sure the instrument is reading zero and all function and range switches are set appropriately.
4. Insert the end of the probe directly into the atmosphere to be measured (e.g., breathing zone, monitoring well casing, split spoon, etc.) and read the total organic vapor concentration in parts per million (ppm) from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.
5. Immediately document the reading in the field logbook or on the appropriate field form.

5.2 Headspace Measurement

1. Connect the measurement probe to the instrument and make necessary operational checks (e.g., battery check, fan check, etc.) as outlined in the manufacturer's manual.
2. Calibrate the instrument following the appropriate manufacturer's manual.
3. Make sure the instrument is reading zero and all function and range switches are set appropriately.
4. Fill a clean glass jar or Ziploc-type plastic bag approximately half-full of the sample to be measured. For a jar, quickly cover the top of the jar with one or two sheets of clean aluminum foil and apply cap to seal the jar. For a bag, quickly seal the bag minimizing volume of air in bag.
5. Allow headspace to develop for approximately 10 minutes. It is generally preferable to shake the sealed jar for 10 to 15 seconds at the beginning and end of headspace development. For a bag, kneed the bag to break apart the sample and maximize sample surface area.

Note: When the ambient temperature is below 0°C (32°F), the headspace development and subsequent measurement shall occur within a heated vehicle or building.

6. For a jar, remove the jar cap and quickly puncture the foil and insert the instrument probe to a point approximately one-half of the headspace depth. Do not let the probe contact the soil. For a bag, quickly puncture the bag wall and insert the probe, wrapping the bag wall around the probe stem to minimize loss of vapors. If using a PID and there is condensation on the inside of the jar or bag, only leave the probe in the jar or bag long enough to obtain a reading. Remove the probe and allow fresh air to flow through the instrument to avoid excess water vapor to build up.

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7. Read the total organic vapor concentration in ppm from the instrument display. Apply the appropriate correction factor if necessary. Record the highest instrument response.
8. Immediately record the reading in the field logbook or on the appropriate field form.

6.0 Restrictions/Limitations

The two methods outlined above are the most commonly used for field measurement of total organic vapors but do not apply to all circumstances. Consult project- or program-specific procedures and guidelines for deviations. Both the PID and FID provide quantitative measurement of total organic vapors, but generally neither instrument is compound-specific. The typical reading range of the PID is 0 to 2,000 ppm, and the typical reading range of the FID is 0 to 10,000 ppm. The FID will measure methane while the PID will not. **Note:** The presence of methane will cause erratic PID measurements. In methane rich environments, toxic organic vapors shall be monitored with an FID. If desired, a charcoal filter can be placed temporarily on the FID inlet probe, which will trap all organic vapors except methane. The filtered (methane only) reading can be subtracted from unfiltered (total organic vapors) to provide an estimate of non-methane organic vapors. The reading accuracy of both instruments can be affected by ambient temperature, barometric pressure, humidity, lithology, etc.

7.0 References

Department of Defense. *Environmental Field Sampling Handbook, Revision 1*. April 2013 or current revision.

Sediment and/or Sludge Sampling

SOP 1-11

Revision: 10

Date: February 2015

Approved:



Signature

Technical Review:

Stuart Barden

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to define requirements for collection and containment of samples collected from freshwater or marine sediment, and/or sludge samples.

2.0 Background**2.1 Definitions**

Sediment - Bottom substrate underlying a body of surface water, whether freshwater or marine, such as a lake pond, harbor, river, bay or other surface water bodies.

Sludge - Bottom substrate underlying an engineered wastewater pond or solid material removed from a wastewater treatment stream or effluent. Sludge materials range in type from dewatered solids to high viscosity liquids. Sludge particles may be suspended throughout the water column or settled to the bottom as the bottom substrate.

Grab Sample - A surface sample from the sediment or sludge taken from a specific location at a given point in time. Used for horizontal characterization of sediment or sludge.

Core Sample - A subsurface sample taken from the sediment or sludge using a coring device that allows for penetration to a greater vertical depth; used for more comprehensive, vertical characterization of sediment or sludge.

Composite - Two or more subsamples taken from the sediment or sludge at a specific location at a specific point in time, which are then combined and homogenized (mixed) to form a single sample when removed from the homogenate.

Discrete - An individual sample that is taken from the sediment or sludge and analyzed as an individual sample, rather than combined or homogenized to create a composite sample.

2.2 Associated Procedures

- SOP 1-2, *Sample Custody*
- SOP 2-1, *Packaging and Shipping Environmental Samples*
- SOP 4-1, *Field Logbook Content and Control*
- SOP 4-2, *Photographic Documentation of Field Activities*
- SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.2 Discussion

Sediment/sludge samples are collected to physically, chemically, and/or biologically characterize the nature of the substrate within a given surface water body. Sediment and sludge samples offer the advantage over surface water samples that they provide a more stable, site-specific, and possibly historical account of contamination or other features than surface water samples, as surface water may be flowing, is transitory, and thus more difficult to ascribe specific characteristics to any given specific location.

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3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this and related SOPs and the required equipment.

Field Team Leader - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other specific SOPs pertaining to specific sample collection requirements. The FTL must also ensure that the quantity, locations, and procedures for collecting sediment/sludge sampling meet the requirements of any approved site-specific plans such as sampling and analysis plans (SAPs), field sampling plans (FSPs), and quality assurance project plans (QAPPs).

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field sampling plan and/or site quality assurance project plan (QAPP).

4.0 Required Equipment

All or part of the equipment listed under the “as needed” category may be required at any specific site, depending on the plan(s) for that site.

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Appropriate sample containers
- Insulated cooler and waterproof sealing tape
- Ice bags or “blue ice”
- Plastic zip-top bags
- Clear waterproof tape
- Personal protective clothing and equipment (e.g. hard hat, etc.)
- Latex or other appropriate gloves, boots
- Rubber boots and/or rubberized waders
- Stainless steel or Teflon® spoons, spatulas, or scoops
- Teflon or stainless steel mixing bowls or trays
- Aluminum foil
- Kimwipe or paper towels
- ½- to ¾-inch (12- to 19-mm) braided nylon line or Teflon-coated wire rope
- Clean plastic sheeting
- Tap and deionized water with spray bottles
- Appropriate photographic equipment and supplies
- Appropriate decontamination equipment and supplies (e.g. detergent, scrub brushes, buckets for capturing investigation-derived waste)
- Eckman, Ponar, Van Veen, or other grab sampling device for depositional area (e.g. stream) sediment or lake sampling
- Chain of Custody forms from laboratory(ies) as appropriate

As needed:

- Global Positioning System (GPS) unit
- Hand or gravity corer with extensions or stainless steel hand auger
- Core liners of Teflon, stainless steel, brass, aluminum, or polybutyrate, as specified in the site-specific plan(s)
- Stainless steel push tubes
- Dredge with 15- to 20-foot (4.5- to 6.0-meter) sampling pole (hollow) and insert (e.g., Peterson, Eckman, Ponar)
- Motorized or other coring device
- Boat with depth finder for deep water or inaccessible shorelines
- Any personal protective equipment specified in the site-specific health and safety plan
- Spare parts for all equipment
- Tape measure

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5.0 Procedures**5.1 Preparation**

The following steps shall be taken when preparing for sampling sediment/sludge:

1. Review site-specific health and safety plan (HSP) and project plans (FSP, QAPP) before initiating sampling activity.
2. Don the appropriate personal protective clothing as described by the HSP.
3. Use field GPS unit to identify selected sediment or sludge samples within the specified tolerance (e.g. within 2 meters, etc.).
4. Where specific locations are unspecified in the project plans, within a stream or river, avoid areas where the channel has been scoured or where bedrock is present, as it may not be possible to collect samples at these locations.
5. Where excessive organic materials (e.g., root mass, leaf litter) or large grain sizes (e.g. medium to coarse gravel) are present, these material should be minimized in the collected sample.
6. Prepare sampling site by laying out clean plastic sheeting on the ground or any flat, level surfaces near the sampling area and place equipment to be used on the plastic.
7. If surface water is present at the sample location, make field measurements in physical, chemical, and biological characteristics of the water (e.g., temperature, dissolved oxygen, conductivity, pH, etc.), as described by the project-specific plans.
8. The samples shall be collected from areas of least to greatest contamination (when known) and, when collecting several samples in one day in a flowing water body, should be always collected from downstream to upstream.
9. When sampling sediment and surface water from the same surface water body, collect surface water samples before sediment samples to avoid collection of resuspended sediment or sludge particulates.
10. Document the sampling events, recording all information in the designated field logbook and take photographs (as appropriate). Document any and all deviations from this SOP in the field notebook and include rationale for changes.
11. The sample collection points should be shown on a site map and described in the field logbook; any deviations from the site plans should be documented, as well as the rationale for this deviation.
12. Label each sample container with the appropriate information. Secure the label by covering it with waterproof clear tape.
13. Decontaminate reusable sampling equipment after sample collection according to SOP 4-5.
14. Procedures for verifying depths of samples must be included in site-specific project plans.
15. Check that a trip blank/temperature blank, when necessary, is included in the chilled cooler. Quality assurance/quality control requirements vary from project to project. Consult the project-specific work plan for quality requirements.

5.2 Sediment/Sludge Sample Collection from Shallow Waters**5.2.1 Method for Collecting Samples for Volatile Organic Compound (VOC) Analysis**

The following steps must be followed when collecting shallow water sediment/sludge VOC samples:

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1. Use a decontaminated stainless steel or Teflon, long-handled scoop, corer, push tube, or dredge to collect the entire sample in one grab. If wading is necessary, approach the sample location from downstream. Do not enter the actual sample area.
2. Retrieve the sampling device and slowly decant off any liquid phase.
3. Immediately fill the specified sample container(s) with the solid. Use a clean stainless steel or Teflon spoon or spatula to completely fill the container(s), ensuring no headspace.

Note: Samples to be analyzed for VOC or other compounds degraded by aeration shall be taken as grab samples. Do not homogenize or composite these samples.

4. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of the container clean with a Kimwipe or clean paper towel. Affix a completed sample label.
5. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
6. Immediately pack all samples into a chilled cooler.

5.2.2 Method for Collecting Samples for Non-volatile, Semi-Volatile Organic and Inorganic Compound Analysis

The following steps must be taken when collecting shallow water sediment or sludge samples for analytes not immediately degraded by aeration:

1. Collect sufficient volume to fill specified sample containers using decontaminated stainless steel or Teflon-lined equipment (scoops, corer, dredge sampler, etc.). If wading is necessary, approach the sample location from downstream. Do not enter the actual sample area.
2. Retrieve the sampling device with the sample and slowly decant off any liquid phase.
3. Pool and homogenize samples in a stainless steel, Teflon, or appropriate pan or mixing bowl, using stainless steel spatula or spoon.
4. Fill each sample container with the homogenized sample to approximately 75 to 90 percent capacity, filling sample containers for organics analyses first.
5. Once each container is filled, close the container with a Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
6. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
7. Immediately pack all samples into a chilled cooler, if required for preservation.

5.3 Subsurface Sediment/Sludge Sample Collection Using a Corer or Auger from Shallow Waters**5.3.1 Method for Collecting Samples for Volatile Organic Compound Analysis Using an Unlined Corer (also applies to augers)**

The following steps must be taken when collecting subsurface sediment or sludge VOC samples that underlie shallow water:

1. At the specified sampling location, force or drive the corer to the specified depth.

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2. Twist and withdraw the corer in a smooth motion.
3. Retrieve the sampling device, remove the corer nosepiece (if possible), and extrude the sample into the specified sampling container(s). Use a clean stainless steel or Teflon spoon or spatula to completely fill the container(s), ensuring no headspace.
4. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of the sample container clean with a Kimwipe or clean paper towel. Affix a completed sample label.
5. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
6. Immediately pack all samples into a chilled cooler.

5.3.2 Method for Collecting Samples for Volatile Organic Compound Analysis Using a Lined Corer

The following steps must be followed when collecting shallow water subsurface sediment/sludge VOC samples that underlie shallow water:

1. Install decontaminated liner(s) in the corer barrel.
2. At the specified sampling location, force or drive the corer to the specified depth.
3. Twist and withdraw the corer in a smooth motion.
4. Retrieve the sampling device, remove the corer nosepiece (if possible) and remove the liner(s), cap the liner(s), and seal the caps with Teflon tape.
5. Wipe the outside of the liner clean with a Kimwipe or clean paper towel. Label the top and bottom ends of the liner(s). Affix a completed sample label.
6. Place capped and sealed liners in individual zip-top plastic bags and seal the bags.
7. Immediately pack all samples into a chilled cooler.

5.3.3 Method for Collecting Samples for Non-volatile, Semi-Volatile Organic and Inorganic Compound Analysis Using a Corer (also applies to augers)

The following steps must be followed when collecting subsurface sediment/sludge samples that underlie shallow water for analytes not degraded by aeration:

1. At the specified sampling location, force or drive the corer to the specified depth.
2. Twist and withdraw the corer in a smooth motion.
3. Retrieve the sampling device. Remove the corer nosepiece (if possible) and extrude the sample into a stainless steel or Teflon-lined pan or bowl. Collect sufficient sample volume to fill all containers.
4. Use a stainless steel or Teflon spoon or spatula to homogenize and then divide the sample material into the appropriate number of sample containers.

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5. Fill each container to approximately 75 to 90 percent capacity, filling containers for organics analyses first. Close the container with a Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
6. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
7. Immediately pack all samples into a chilled cooler.

5.4 Sediment or Sludge Sample Collection Using a Dredge (Grab) Sampler from Deeper Waters**5.4.1 Method for Collecting Samples for Volatile Organic Compound Analysis**

The following steps must be followed when collecting deep-water sediment/sludge VOC samples:

1. Attach a clean piece of ½- to ¾-inch (12- to 19-mm) braided nylon line or Teflon-coated wire rope to the top of the dredge sampler. The line must be of sufficient length to reach the sediment or sludge and have enough slack to release the mechanism. Mark the distance to the bottom on the line.
2. Attach the free end of the sampling line to a fixed support to prevent loss of the sampler.
3. At the specified sampling location, open the sampler jaws and slowly lower the sampler until contact with the bottom (sediment/sludge) is felt.
4. Release tension on the line; allow sufficient slack for the mechanism (latch) to release. Slowly raise the sampler to reduce disturbance of the sampler to the extent possible.
5. Once the sampler is above the water surface, place the sampler in a stainless steel or Teflon-lined tray or pan. Open the sampler. Immediately collect the sample for VOC analysis, using a stainless steel or Teflon spoon or spatula. Fill each container completely to minimize headspace.
6. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
7. Place the sample container(s) in individual zip-top plastic bags and seal the bags.
8. Immediately pack all samples into a chilled cooler.

5.4.2 Method for Collecting Samples for Non-volatile, Semi-volatile Organic and Inorganic Compounds

The following steps must be followed when collecting deep-water sediment/sludge samples for analytes not degraded by aeration:

1. Attach a clean piece of ½- to ¾-inch (12- to 19-mm) braided nylon line or Teflon-coated wire rope to the top of the sampler. The line must be of sufficient length to reach sediment or sludge and have enough slack to release the mechanism. Mark the distance to the bottom on the line.
2. Attach the free end of the sampling line to a fixed support to prevent loss of the sampler.
3. At the specified sampling location, open the sampler jaws and slowly lower the sampler until contact with the bottom (sediments/sludge) is felt.
4. Release tension on the line; allow sufficient slack for the mechanism (latch) to release. Slowly raise the sampler to reduce disturbance of the sampler to the extent possible.

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5. Once the sampler is above the water surface, place the sampler in a stainless steel or Teflon-lined tray or pan. Open the sampler.
6. Collect sufficient volume of sample to fill the specified sampler containers, and place the material into a clean stainless steel bowl or other container to homogenize the sample. If compositing is required, pool the grab samples in a tray or other container, and homogenize the pooled samples by mixing them together with a stainless steel or Teflon spoon or spatula.
7. Fill the specified sample containers to approximately 75 to 90 percent capacity with the homogenized sample using the stainless steel or Teflon spoon or spatula. Fill sample containers for organics analyses first.
8. Once each container is filled, close the container with the Teflon-lined cap. Wipe the outside of sample containers clean with a Kimwipe or clean paper towel. Affix a completed sample label.
9. Place sample container(s) in individual zip-top plastic bags and seal the bags.
10. Immediately pack all samples into a chilled cooler.

6.0 Restrictions/Limitations

Core sampling devices may not be usable if cobbles exist in the sediment/sludge. Bumping of core sampling devices and Ponar dredge samplers may result in the loss of some of the sample.

Grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample, however, is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

7.0 References

Department of Defense. *Environmental Field Sampling Handbook, Revision 1*. April 2013 or current revision.

Mudroch, A. and S.D. MacKnight. 1991. *Handbook of Techniques for Aquatic Sediment Sampling*. CRC Press, Inc. 210 p.

U.S. Environmental Protection Agency, Region IV. *Science and Ecosystem Support Division, Operating Procedure SESDPROC-300-R3*. August 2014 or current revision.

U. S. Geological Survey. *National Field Manual for the Collection of Water-Quality Data*, Chapter A8. October 1997.

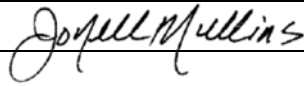
Low- Stress (Low-Flow) Groundwater Sampling

SOP 1-12

Revision: 2

Date: February 2015

Approved:



Technical Review:

Lynne France

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to define the procedural requirements for low-flow (minimal drawdown) groundwater sampling.

2.0 Background

Low-flow groundwater sampling is a method of collecting samples from a well that, unlike traditional purging methods, does not require the removal of large volumes of water from the well. The objective of low-flow groundwater sampling is to collect samples with minimal alterations to water chemistry through pumping the well at a rate low enough to minimize drawdown and to avoid disturbance in the well. Low-flow groundwater sampling refers to the velocity with which water enters the pump intake, and that which is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface of the well which can be affected by flow regulators or restrictions.

Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective of low-flow groundwater sampling is to pump the well in a manner that minimizes stress (drawdown) to the system. Minimal drawdown must be stabilized such that the water to be sampled is representative of the formation surrounding the screened interval, and is not from the stagnant water column above the screened interval. Minimal drawdown is achieved to the extent practical taking site sampling objectives into account. Typically flow rates on the order of 0.1 to 0.5 liter per minute (L/min) are used. However, achieving flow rates of 0.1 to 0.5 L/min can be dependent on site-specific hydrogeology. Some very coarse-textured formations have successfully been sampled via low-flow techniques at flow rates up to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper well screen location, well screen length, and well construction and development techniques.

Low-flow groundwater sampling can be used to collect samples for all categories of aqueous-phase contaminants and naturally occurring analytes, including volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), and other organic compounds; metals and other inorganics; pesticides; polychlorinated biphenyls (PCBs); radionuclides; and microbiological constituents. Low-flow groundwater sampling techniques are particularly well-suited in applications where it is desirable to sample aqueous-phase constituents that may sorb or partition to particulate matter. It is not applicable to sampling wells that contain either light or dense non-aqueous-phase liquids (LNAPLs or DNAPLs).

A variety of sampling devices are available for low-flow groundwater sampling, including peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Pump type should be selected based on known site conditions, including well depth, well diameter, water level, and anticipated well volume, as well as sampling objectives. Note that peristaltic pumps (suction pumps) cannot be used under conditions in which the water table is greater than 25 feet below ground surface. Additionally, in most instances, peristaltic pumps may not be used for collecting VOC samples because they create a vacuum that potentially contributes bias to sampling for VOC's via low flow techniques. Bailers, too, are generally inappropriate devices for low-flow sampling. Gas-driven pumps are generally not advisable for VOC or SVOC sample collection due to the potential for sample contamination.

Dedicated pumps (those which are permanently installed in the well –e.g., bladder pumps) are preferred over portable pumps because they eliminate disturbance to the water column in the well during pump insertion, thus providing lower turbidity values, shorter purge times, and lower purge volumes to achieve stabilized indicator parameter measurements. However, portable pumps can be used if care is taken to minimize disturbance to the water column during pump insertion, and if adequate time is allowed following pump insertion and prior to pump operation for any particulates agitated in the water column to settle. Both dedicated and portable pumps should be easily adjustable, and should operate reliably at lower flow rates. All pumps typically have some limitations which should be evaluated with respect to site-specific considerations and data quality objectives on a case-by-case basis.

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Water quality indicator parameters should be continuously monitored during low-flow purging using a flow-through cell, or in-line parameter monitoring techniques. Continuous indicator parameter monitoring is a critical component to low-flow groundwater sampling. Water quality indicator parameters include temperature, pH, oxidation-reduction potential (ORP), specific conductivity, dissolved oxygen (DO), and turbidity. The flow-through cell enables continuous collection of real-time parameters during low-flow purging. Stabilization is achieved after all parameters fall within established limits for three successive readings as discussed in Section 5. Stabilization of low-flow parameters is further discussed in Section 5.0 (Procedure) of this SOP.

Advantages of low-flow groundwater sampling are:

- Improved sample quality (e.g., less turbid and more representative of the aquifer)
- Potentially reduced purging and sampling times
- Reduced purge water volume

2.1 Associated Procedures

- SOP 1-6, *Water Level Measurement*
- SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*
- SOP 2-2, *Guide to Handling of Investigation Derived Waste*

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that well development and purging are carried out in accordance with this procedure.

Field Team Leader - The field team leader is responsible for complying with this procedure.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment

- Pump (including peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps as discussed in Section 2.0 of this SOP)
- Appropriate controller for selected pump type
- For bladder pumps: Compressor and controller for the system (compressed non-reactive gas may also be used in lieu of a compressor)
- Power source (e.g., battery or generator), as required
- Pump tubing (typically polyethylene with Teflon® lining). Note that portable bladder pumps require combination tubing (for air and water); therefore the correct tubing sizes for the portable bladder pump should be verified. Additionally, peristaltic pumps require flexible tubing (silicone or Tygon) tubing for the pump head.
- Electronic water level meter or oil-water interface probe (according to SOP 1-6)
- Water quality meter (e.g., YSI 600 Series) with a closed flow-through cell for continuous in-line measurement of temperature, pH, conductivity, ORP, and DO prior to sample collection
- Turbidity meter (Reporting in nephelometric turbidity units [NTUs])
- Standards for calibration and field check, as needed, of water quality and turbidity meters (as determined by anticipated field conditions)
- Volume measuring device to determine flow (e.g., graduated cylinder)
- Stop watch
- Tape measure
- Personal protective equipment as specified in the site-specific health and safety plan
- Polyethylene sheeting

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- Sample containers, including packaging supplies and all associated paperwork (e.g., chain of custody forms) as required in the sampling plan and/pr SOP 2-1, Packaging and Shipping Environmental Samples
- Decontamination supplies, as required, according to SOP 4-5
- Disposal drums (e.g., 55-gallon Department of Transportation-approved) or other purge water storage container, if required by the site-specific sampling plan
- Photoionization detector (PID)/organic vapor monitor (OVM) or equivalent as specified in site-specific health and safety plan

Note: All sampling devices (bladders, pumps, and tubing) should be constructed of stainless steel, polyethylene, Teflon®, glass, or similar non-reactive materials.

5.0 Procedure

The following steps must be followed for low-flow groundwater sampling activities:

1. Review site-specific health and safety plan, and site-specific project and sampling plans before initiating sampling activities.
2. Review available existing data for site to evaluate approach to sampling site wells: prepare to sample site wells in the order of least contaminated to most contaminated. Additionally, existing site data should be reviewed to determine anticipated hydrogeologic conditions and well completion details.
3. Prior to sampling, all sampling devices and monitoring equipment shall be calibrated according to manufacturer's recommendations and the site-specific sampling plan. Calibration of pH should be performed with at least two buffers which bracket the expected pH range. DO calibrations should be corrected for local barometric pressure readings and altitude.
4. Put on personal protective clothing and equipment as specified in the site-specific health and safety plan.
5. Open the well cover and check condition of the wellhead, including the condition of the surveyed reference mark, if any. If no reference mark exists, create a reference mark on the north side of the well riser using a permanent marker or equivalent. Record the location of the reference mark in the field notes.
6. Monitor the air space at the wellhead for VOCs using a PID/OVM or equivalent immediately upon removal of the well plug and as according to health and safety requirements.
7. Determine the depth to static water level in accordance with SOP 1-6, taking precautions to minimize disturbance of the stagnant water column above the screened interval during water level measurement. Well depth should be obtained from review of the well completion logs or from previous work. Insertion of a water level measuring device to the bottom of the well casing will result in resuspension of settled solids from the formation surrounding the screened interval, thus requiring longer purging times for turbidity and other field parameter equilibration.
8. Dedicated sampling devices (those permanently installed in the well) capable of pumping and sampling are preferred over any other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids collected at the bottom of the well or in the surrounding formation within the screened interval.
9. New polyethylene tubing shall be used for each sample when using non-dedicated sampling equipment. Prepare the pump and tubing for insertion into the well. Lower the pump intake down into the well casing. Connect the flow-through cell in-line with the pump effluent tubing.

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10. Generally, the pump intake should be placed in the mid-point of the screened interval. This provides consistency between sampling rounds. However, if the geology of the screened interval consists of heterogeneous materials with layers of contrasting hydraulic conductivity, the pump intake should be positioned adjacent to the zone of highest hydraulic conductivity (as determined via review of the existing site hydrogeologic conditions/well completion logs). Also, the sampling plan should be consulted to determine if particular zones (e.g., known zones of contamination) are targeted for sampling per DQOs).
11. To achieve low-flow purging conditions, the purge rate should generally not exceed 0.5 L/min. Adjust the pump control to stabilize the flow rate, and therefore minimize drawdown (less than 0.3 foot during purging activities). The water level in the well should be measured throughout the purging process to monitor drawdown. Flow rate can be measured from the discharge tube using a volumetric measuring device (e.g., a graduated cylinder) and a stop watch (Note: determine flow rate by measuring volume in 0.5-minute or 1-minute increments.)
12. Record water level measurements, and field parameters including pH, temperature, specific conductivity, oxidation reduction potential (ORP), DO, turbidity, and flow rate every three to five minutes during the purging process. Record all measurements and observations in the log book or on a Groundwater Purging and Sampling Form (Attachment 1). Purging shall continue until the field parameters have stabilized. Parameters are considered stable when three consecutive readings are within the limits of the criteria defined in Table 5.1 and/or in accordance with the site-specific sampling plan. Turbidity ideally should stabilize below 10 NTU prior to sample collection, particularly if groundwater samples are to be collected for metals or PCB analyses.

TABLE 5.1 Stabilization of Water Quality Indicator Parameters

Parameter	Units	Stabilization Criteria
Water Level	Feet/meters	< 0.3 foot (< 0.1 meter)
Temperature	°F/°C	± 3 percent, or ±1.8 degrees Fahrenheit (°F) /±1 degree Celsius (°C)
pH	(n/a)	± 10 percent, or ±0.1 standards units (SU)
Specific Conductivity	µm/cm	±3 percent (microsiemens per centimeter, or µm/cm)
ORP	mV	±10 millivolts (mV)
Dissolved Oxygen	mg/L	±10 percent, or 0.2 milligram per liter (mg/L) - whichever is greater
Turbidity	NTU	± 1 Nephelometric Turbidity Unit (NTU) (±10 percent for turbidity if greater than 10 NTU)
Flow Rate	L/min	0.1 to 0.5 Liters per minute (L/min) (< 1 L/min), Specific flow rates and sampling rates to be identified in the sampling plan if project/contract required.

13. In low recharge aquifers, the following steps shall be followed:
 - (1) If the initial water level is less than 10 feet above the top of the well screen, then purge the well until dry and allow sufficient recharge to collect samples.
 - (2) If the initial water level in the well is greater than 10 feet above the top of the screen, then care shall be taken to prevent the dewatering of the screened interval during purging of the well.
 - (2a) Continue purging until the water level is between 1 foot (0.3 meter) and 5 feet (1.5 meters) above the top of the screened interval.
 - (2b) Allow the well to recharge, then continue purging until at least one full initial well volume has been purged.
 - (3) Record all data, measurements, and observations in the log book.
14. After field parameters have stabilized, disconnect the flow through cell, and collect groundwater samples directly from the discharge tubing into an appropriate sample container. If using a peristaltic pump to collect VOC samples, refer to item 16 of this SOP for the correct procedure for sampling VOCs with a peristaltic pump. If an in-line, flow-through cell is used to continuously monitor indicator parameters, it should be disconnected or bypassed during sample collection. During sample collection, maintain the pump rate at the same rate used during purging (unless specified in the sampling plan). The pump rate used during sample collection may need to be lowered to minimize aeration, bubble formation, or turbulent flow of water into sample bottles, or to prevent sample preservatives from being washed out of the sample container.

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15. Groundwater sampling (including the collection of all required quality assurance/quality control samples specified in the sampling plan) shall be performed immediately upon completion of purging (unless time for recharge is required for low-recharge wells) using the same equipment used for purging. Sampling should occur in a progression from the least to the most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+} , CH_4 , $\text{H}_2\text{S}/\text{HS}^-$, and alkalinity) analytes should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are required. Filtered samples should be collected last and in-line filters should be used. After all unfiltered samples have been collected, a 0.45 micron (μm) in-line filter shall be inserted in the discharge line for collection of filtered samples, as required.
16. VOC samples should not be collected directly from the discharge end of a peristaltic pump. After field parameters have stabilized, and all other samples have been collected as required, stop the pump and simultaneously pinch the discharge end of the tubing shut. Disconnect the flow-through cell. Remove the tubing from the well and fill the VOC sample containers from the influent end of the sample tubing, (the end of the tubing that was located down-well during purging activities). The flow rate when filling sample vials may be controlled by setting the peristaltic pump in reverse.
17. Place all samples in a cooler with ice or ice packs to comply with project, laboratory, and/or regulatory requirements.
18. After sampling activities have been completed, remove the portable pump assembly from the well, if used, and decontaminate all non-disposable components. Replace the well plug. Secure the well plug and well cover. Clean up the work area: containerize and/or dispose of purge water as required by the site-specific sampling plan, and dispose of tubing and all other disposable sampling equipment as investigation derived waste (IDW) after each use as described in the site-specific sampling plan.

6.0 Restrictions/Limitations

Only grounded electrical devices should be used for low-flow sampling activities. If a gasoline-powered electrical source is used, place portable power sources (e.g., generators) 50 feet (15 meters) or farther from the wellhead to prevent potential contamination of samples. Additionally, it should be clearly noted in the field notes or on the Groundwater Sampling Log (Attachment 1) if a well has been pumped dry and allowed to recharge prior to sample collection, as low-flow sampling data is no longer applicable.

7.0 References

ASTM D6452-99(2012)e1, Standard Guide for Purging Methods for Wells Used for Groundwater Quality Investigations, ASTM International, West Conshohocken, PA, 2012.

ASTM D4448-01(2013), Standard Guide for Sampling Ground-Water Monitoring Wells, ASTM International, West Conshohocken, PA, 2013.

Puls, R.W. and M.J. Barcelona. April 1996. *Low-Flow (Minimal Drawdown) Ground Water Sampling Procedures*. U.S. EPA, Ground Water Issue, Publication Number EPA/540/S-95/504.

U. S. Environmental Protection Agency. May 2002. *Groundwater Sampling Guidelines for Superfund and RCRA Project Managers*. Ground Water Forum Issue Paper, EPA 542-S-02-001, OSWER, Technology Innovative Office, Washington, D.C.

Low- Stress (Low-Flow) Groundwater Sampling

SOP 1-12

Revision: 2

Date: February 2015

Attachment 1

EXAMPLE LOW-FLOW GROUNDWATER SAMPLING PURGING DATA SHEET

Site Name: _____ Date: _____

OVM: FID ☐ PID ☐ In Casing (ppm): (Initial) _____ (Vented to) _____

Well ID: _____

Purging/Sampling Device: _____

Initial Static Water Level (feet btoc): _____

Analytical Parameters: _____

Final Water Level (feet btoc): _____

QC Samples Collected: _____

Purge Start Time: _____

Sample Number: _____

Sample Time: _____

Samplers' Signatures: _____

[illegible]

Parameter	Units	Stabilization Criterion
Water Level	Feet/meters	< 0.3 foot (< 0.1 meter)
Temperature	°F/°C	± 3 percent, or ±1.8 degrees Fahrenheit (°F) /±1 degree Celsius (°C)
pH	(n/a)	± 10 percent, or ±0.1 standards units (SU)
Specific Conductivity	µm/cm	±3 percent (microsiemens per centimeter, or µm/cm)
ORP	mV	±10 millivolts (mV)
Dissolved Oxygen	mg/L	±10 percent, or 0.2 milligram per liter (mg/L) - whichever is greater
Turbidity	NTU	± 1 Nephelometric Turbidity Unit (NTU) (±10 percent for turbidity if greater than 10 NTU)
Flow Rate	L/min	0.1 to 0.5 Liters per minute (L/min) (< 1 L/min)

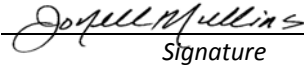
Packaging and Shipping Environmental Samples

SOP 2-1

Revision: 6

Date: February 2015

Approved:



Signature

Technical Review:

T. Burgesser/C. Zakowski

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to outline the requirements for the packaging and shipment of environmental samples. Additionally, Sections 2.0 through 7.0 outline requirements for the packaging and shipping of regulated environmental samples under the Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations for shipment by air and applies only to domestic shipments. This SOP does not cover the requirements for packaging and shipment of equipment (including data loggers and self-contained breathing apparatus [SCBAs] or bulk chemicals that are regulated under the DOT, IATA, and ICAO.

1.1 Packaging and Shipping of All Samples

This SOP applies to the packaging and shipping of all environmental samples. If the sample is preserved or radioactive, the following sections may also be applicable.

- Section 2.0 - Packaging and Shipping Samples Preserved with Methanol
- Section 3.0 - Packaging and Shipping Samples Preserved with Sodium Hydroxide
- Section 4.0 - Packaging and Shipping Samples Preserved with Hydrochloric Acid
- Section 5.0 - Packaging and Shipping Samples Preserved with Nitric Acid
- Section 6.0 - Packaging and Shipping Samples Preserved with Sulfuric Acid
- Section 7.0 - Packaging and Shipping Limited-Quantity Radioactive Samples

NOTE: This SOP does not address shipment of hazardous materials. Don't ship a hazardous material unless you have received training that meets the requirements of CDM Smith and the DOT. Check with CDM Smith University for training courses.

1.2 Background**1.2.1 Definitions**

Environmental Sample - An aliquot of air, water, plant material, sediment, or soil that represents the contaminant levels on a site. Samples of potential contaminant sources, like tanks, lagoons, or non-aqueous phase liquids are normally not "environmental" for this purpose. This procedure applies only to environmental samples that contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

Custody Seal - A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the container (i.e., cooler) before offsite shipment. Custody seals are used to demonstrate that sample integrity has not been compromised during transportation from the field to the analytical laboratory.

Inside Container - The container, normally made of glass or plastic, that actually contacts the shipped material. Its purpose is to keep the sample from mixing with the ambient environment.

Outside Container - The container, normally made of metal or plastic, that the transporter contacts. Its purpose is to protect the inside container.

Secondary Containment - The outside container provides secondary containment if the inside container breaks (i.e., plastic overpackaging if liquid sample is collected in glass).

Excepted Quantity - Excepted quantities are limits to the mass or volume of a hazardous material in the inside and outside containers below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

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Limited Quantity - Limited quantity is the maximum amount of a hazardous material below which there are specific labeling or packaging exceptions.

Performance Testing - Performance testing is the required testing of outer packaging. These tests include drop and stacking tests.

Qualified Shipper - A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

1.2.2 Associated Procedures

- SOP 1-2, *Sample Custody*

1.2.3 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both CDM Smith and the individual employee at risk of serious fines. The analytical holding times for the samples must not be exceeded. The samples shall be packed in time to be shipped for overnight delivery. Make arrangements with the laboratory before sending samples for weekend delivery.

1.3 Required Equipment

- Coolers with return address of the appropriate CDM Smith office
- Heavy-duty plastic garbage bags
- Plastic zip-type bags, small and large
- Clear tape
- Nylon reinforced strapping tape
- Duct tape
- Kitty litter/pine bedding (or an equivalent nonflammable material that is inert and absorbent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or contract laboratory program (CLP) custody records, if applicable
- Completed bill of lading
- This End Up and directional arrow labels

*Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

1.4 Packaging Environmental Samples

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager shall be observed.
2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Ensure the handles used for carrying the cooler are in good repair. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic garbage bag.
3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, *Sample Custody*).
4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three volatile organic analyte (VOA) vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. VOA vials may be packaged in foam containers designed for packaging them as well. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with kitty litter/pine bedding or equivalent. **Note:** Trip blanks must be included in coolers containing VOA samples.

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5. Place 2 to 4 inches of an absorbent material into a cooler that has been lined with a garbage bag, and then place the bottles and cans in the bag with sufficient space to allow for the addition of packing material between the bottles and cans. It is preferable to place glass sample bottles and jars into the cooler vertically. Glass containers are less likely to break when packed vertically rather than horizontally.
6. While placing sample containers into the cooler, conduct an inventory of the contents of the shipping cooler against the chain-of-custody record. The chain-of-custody with the cooler shall reflect only those samples within the cooler.
7. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° Celsius (C) if the analytical method requires cooling. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with fiber or duct tape.
8. Place the completed chain-of-custody record or the CLP traffic report form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler lid and close the cooler.
9. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the opening of the cooler on opposite sides. The custody seals shall be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.
10. The shipping container lid must be marked **"THIS END UP"** and arrow labels that indicate the proper upward position of the container shall be affixed to the cooler. A label containing the name and address of the shipper (CDM Smith) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container, or when shipping by common courier, the bill of lading shall be completed and attached to the lid of the shipping container.

2.0 Packaging and Shipping Samples Preserved with Methanol

2.1 Containers

1. The maximum volume of methanol in a sample container is limited to 30 milliliters (ml).
2. The sample container must not be full of methanol.

2.2 Responsibility

It is the responsibility of the qualified shipper to:

1. Ensure that the samples undergoing shipment contain no other contaminant that meets the definition of "hazardous material" as defined by DOT.
2. Determine the amount of preservative in each sample so that accurate determination of quantities can be made.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

2.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

1. Inner packing may consist of glass or plastic jars

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2. Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
3. Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
4. Class 3 flammable liquid labels
5. Orientation labels
6. Consignor/consignee labels

2.4 Packaging Samples Preserved with Methanol

The following steps are to be followed when packaging limited-quantity sample shipments:

1. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
2. All sample containers will be properly labeled and the label protected with waterproof tape before sampling.

At a minimum the label must contain:

- | | |
|--------------------------------------|---|
| ▪ Project name | ▪ Sample identification number |
| ▪ Project number | ▪ Collector's initials |
| ▪ Date and time of sample collection | ▪ Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form) |
| ▪ Sample location | |

3. Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
4. Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
5. Place wrapped containers inside a polyethylene bottle filled with an absorbent; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
6. Total volume of methanol per shipping container must not exceed 500 ml.
7. Place sufficient amount of an absorbent in the bottom of the cooler to absorb any leakage that may occur.
8. Place a garbage bag in the cooler.
9. Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
10. Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
11. Seal the garbage bag by tying or taping.
12. The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
13. Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
14. If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.

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15. Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
16. Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
17. Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Methanol Mixture
UN1230
LTD. QTY.

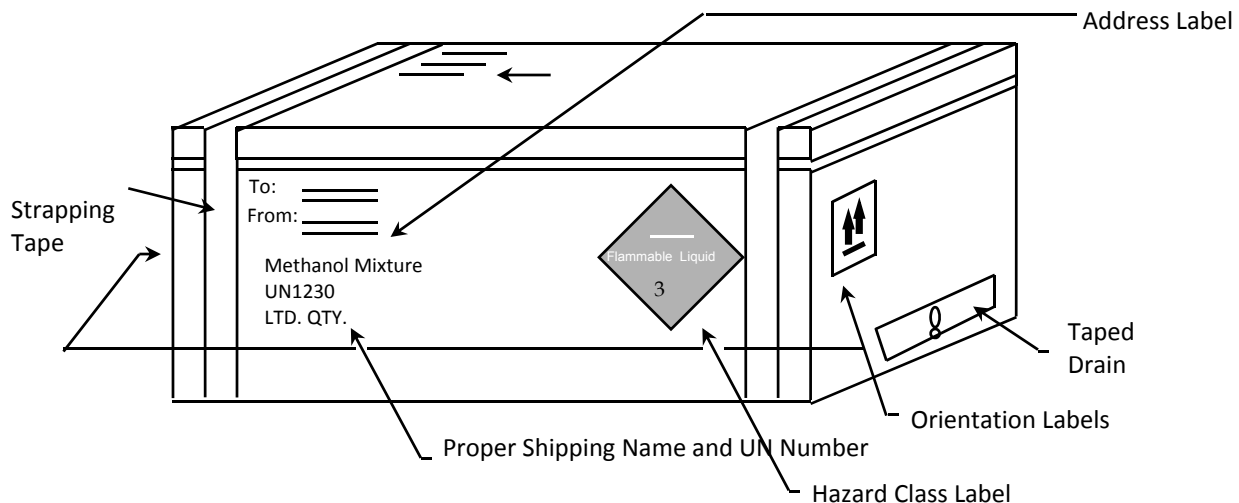
18. Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
19. Affix a Flammable Liquid label to the outside of the cooler.
20. Affix package orientation labels on two opposite sides of the cooler.
21. Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment. An example of cooler labeling/marking locations is shown in Figure 1.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

22. When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 millirem/hour (mrem/h) on all sides. This survey will be documented and the results reviewed by the qualified shipper.
23. Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity(Appendix A).
24. Complete a Dangerous Goods Airbill.

Figure 1
Example of Cooler Label/Marking Locations



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3.0 Packaging and Shipping Samples Preserved with Sodium Hydroxide

3.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sodium Hydroxide Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
NaOH	30%	>12	0.08%		.25	0.5	1	2

5 drops = 1 ml

3.2 Responsibility

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific QAPP.

3.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Inner packings may consist of glass or plastic jars no larger than 1 pint
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

3.4 Packaging Samples Preserved with Sodium Hydroxide

Samples containing sodium hydroxide (NaOH) as a preservative that exceed the excepted concentration of 0.08 percent (2 ml of a 30 percent NaOH solution per liter) may be shipped as a limited quantity per packing instruction Y819 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

1. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
2. All sample containers will be properly labeled and the label protected with waterproof tape before sampling.

At a minimum the label must contain:

- | | |
|--------------------------------------|---|
| ▪ Project name | ▪ Sample identification number |
| ▪ Project number | ▪ Collector's initials |
| ▪ Date and time of sample collection | ▪ Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form) |
| ▪ Sample location | |
3. This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.

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4. Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
5. Place glass containers inside a polyethylene bottle filled with an absorbent; seal the bottle.
6. The total volume of sample in each cooler must not exceed 1 liter.
7. Place sufficient amount of an absorbent in the bottom of the cooler to absorb any leakage that may occur.
8. Place a garbage bag in the cooler.
9. Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
10. Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
11. Seal the garbage bag by tying or taping.
12. The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
13. Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
14. If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
15. Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
16. Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
17. Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Sodium Hydroxide Solution
UN1824
LTD. QTY.

18. Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
19. Affix a Corrosive label to the outside of the cooler.
20. Affix package orientation labels on two opposite sides of the cooler.
21. Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment. An example of cooler labeling/marketing locations is shown in Figure 1.

Note: Samples meeting the exception concentration of 0.08 percent NaOH by weight may be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

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22. When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
23. Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
24. Complete a Dangerous Goods Air Bill.

4.0 Packaging and Shipping Samples Preserved with Hydrochloric Acid

4.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Hydrochloric Acid Preservatives

<i>Preservative</i>		<i>Desired in Final Sample</i>		<i>Quantity of Preservative (ml) for Specified Container</i>		
		pH	Conc.	40 ml	125 ml	250 ml
HCl	2N	<1.96	0.04%	.2	.5	1

5 drops = 1 ml

4.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific QAPP.

4.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packing may consist of glass or plastic jars no larger than 1 pint.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

4.4 Packaging Samples Preserved with Hydrochloric Acid

The following steps are to be followed when packaging limited-quantity sample shipments:

1. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
2. All sample containers will be properly labeled and the label protected with waterproof tape before sampling.

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At a minimum the label must contain:

- Project name
 - Project number
 - Date and time of sample collection
 - Sample location
 - Sample identification number
 - Collector's initials
 - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
 - Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
 - Place wrapped containers inside a polyethylene bottle filled with an absorbent; seal the bottle. (No more than 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
 - Total volume of sample inside each cooler must not exceed 1 liter.
 - Place sufficient amount of an absorbent in the bottom of the cooler to absorb any leakage that may occur.
3. Place a garbage bag in the cooler.
 4. Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
 5. Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
 6. Seal the garbage bag by tying or taping.
 7. The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
 8. Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
 9. If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
 10. Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
 11. Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
 12. Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).
- Hydrochloric Acid Solution**
UN1789
LTD. QTY.
13. Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
 14. Affix a Corrosive label to the outside of the cooler.
 15. Affix package orientation labels on two opposite sides of the cooler.

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16. Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment. An example of cooler labeling/marketing locations is shown in Figure 1.

Note: Samples containing less than the exception concentration of 0.04 percent HCl by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.

Note: No marking or labeling can be obscured by strapping or duct tape.

Note: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.

17. When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
18. Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
19. Complete a Dangerous Goods Airbill.

5.0 Packaging and Shipping Samples Preserved with Nitric Acid

5.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Nitric Acid Preservatives

<i>Preservative</i>		<i>Desired in Final Sample</i>		<i>Quantity of Preservative (ml) for Specified Container</i>				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
HNO ₃	6N	<1.62	0.15%		2	4	5	8

5 drops = 1 mg/L

5.2 Responsibility

It is the responsibility of the qualified shipper to:

1. Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.
2. Determine the amount of preservative in each sample so that accurate determination of quantities can be made.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific QAPP.

5.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

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5.4 Packaging Samples Preserved with Nitric Acid

Samples containing nitric acid (HNO_3) as a preservative that exceed the excepted concentration of 0.15 percent HNO_3 will be shipped as a limited quantity per packing instruction Y807 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity sample shipments:

1. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
2. All sample containers will be properly labeled and the label protected with waterproof tape before sampling.

At a minimum the label must contain:

▪ Project name	▪ Sample identification number
▪ Project number	▪ Collector's initials
▪ Date and time of sample collection	▪ Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
▪ Sample location	
3. This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
4. Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
5. Place glass containers inside a polyethylene bottle filled with an absorbent; seal the bottle.
6. Place sufficient amount of an absorbent in the bottom of the cooler to absorb any leakage that may occur.
7. Place a garbage bag in the cooler.
8. Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
9. Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
10. Seal the garbage bag by tying or taping.
11. The maximum volume of preserved solution in the cooler must not exceed 500 ml.
12. The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
13. Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
14. If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
15. Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
16. Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
17. Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Nitric Acid Solution (with less than 20 percent)

UN2031

Ltd. Qty.

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18. Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
 19. Affix a Corrosive label to the outside of the cooler.
 20. Affix package orientation labels on two opposite sides of the cooler.
 21. Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment. An example of cooler labeling/marketing locations is shown in Figure 1.
- Note:** Samples meeting the exception concentration of 0.15 percent HNO₃ by weight will be shipped as nonregulated or nonhazardous following the procedure in Section 1.4.
- Note:** No marking or labeling can be obscured by strapping or duct tape.
- Note:** The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.
22. When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
 23. Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
 24. Complete a Dangerous Goods Airbill.

6.0 Packaging and Shipping Samples Preserved with Sulfuric Acid

6.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

Excepted Quantities of Sulfuric Acid Preservatives

Preservative		Desired in Final Sample		Quantity of Preservative (ml) for Specified Container				
		pH	Conc.	40 ml	125 ml	250 ml	500 ml	1 L
H ₂ SO ₄	37N	<1.15	0.35%	.1	.25	0.5	1	2

5 drops = 1 ml

6.2 Responsibility

It is the responsibility of the qualified shipper to:

1. Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.
2. Determine the amount of preservative in each sample so that accurate determination of quantities can be made.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific QAPP.

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6.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

6.4 Packaging of Samples Preserved with Sulfuric Acid

Samples containing sulfuric acid (H_2SO_4) as a preservative that exceed the excepted concentration of 0.35 percent will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments:

1. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
2. All sample containers will be properly labeled and the label protected with waterproof tape before sampling.

At a minimum the label must contain:

- | | |
|--------------------------------------|---|
| ▪ Project name | ▪ Sample identification number |
| ▪ Project number | ▪ Collector's initials |
| ▪ Date and time of sample collection | ▪ Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form) |
| ▪ Sample location | |

3. Wrap each glass container in bubble wrap (secure with waterproof tape) to prevent breakage.
4. Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
5. Place glass containers inside a polyethylene bottle filled with an absorbent; seal the bottle.
6. Place sufficient amount of an absorbent in the bottom of the cooler to absorb any leakage that may occur.
7. Place a garbage bag in the cooler.
8. Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
9. Place sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
10. Seal the garbage bag by tying or taping.
11. The maximum volume of preserved solution in the cooler must not exceed 500 ml.
12. The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
13. Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.

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14. If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
15. Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
16. Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
17. Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

Sulfuric Acid Solution
UN2796
LTD. QTY.

18. Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
 19. Affix a Corrosive label to the outside of the cooler.
 20. Affix package orientation labels on two opposite sides of the cooler.
 21. Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment. An example of cooler labeling/marketing locations is shown in Figure 1.
- Note:** Samples containing less than the exception concentration of 0.35 percent H_2SO_4 by weight will be shipped as nonregulated or nonhazardous in accordance with the procedure described in Section 1.4.
- Note:** No marking or labeling can be obscured by strapping or duct tape.
- Note:** The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other nonregulated environmental samples may be added to the cooler for shipment.
22. When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
 23. Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
 24. Complete a Dangerous Goods Airbill.

7.0 Packaging and Shipping Limited-Quantity Radioactive Samples**7.1 Containers**

The inner packaging containers that may be used for these shipments include:

1. Any size sample container

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7.2 Description/Responsibilities

The qualified shipper will determine that the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.

The qualified shipper will ship all samples that meet the Class 7 definition of radioactive materials and meet the activity requirements specified in Table 4 and 7 of 49 CFR 173.425, as Radioactive Materials in Limited Quantity. The qualified shipper will verify that all packages and their contents meet the requirements of 49 CFR 173.421, *Limited Quantities of Radioactive Materials*.

The packaging used for shipping will meet the general requirements for packaging and packages specified in 49 CFR 173.24 and the general design requirements provided in 173.410. These standards state that a package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal condition of transport without any deterioration in the effectiveness of the closing devices on the various receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.

If the shipment is from a DOE facility, radiological screenings will be completed on all samples taken. The qualified shipper will review the results of each screening (alpha, beta, and gamma speciation). Samples will not be shipped offsite until the radiological screening has been performed.

The total activity for each package will not exceed the relevant limits listed in Table 4 and 7 of 49 CFR 173.425. The A_2 value of the material will be calculated based on all radionuclides found during previous investigations (if any) in the area from which the samples are derived. The A_2 values to be used will be the most restrictive of all potential radionuclides as listed in 49 CFR 173.435.

The radiation level at any point on the external surface of the package bearing the sample(s) will not exceed 0.005 millisievert per hour (mSv/h) (0.5 mrem/hour). These will be verified by dose and activity monitoring before shipment of the package.

The removable radioactive surface contamination on the external surface of the package will not exceed the limits specified in 49 CFR 173.443(a). CDM Smith will apply the DOE-established free release criteria for removable surface contamination of less than 20 dpm/100 cm² (alpha) and 1,000 dpm/100 cm² (beta/gamma). It shall be noted that these values are more conservative than the DOT requirements for removable surface contamination.

The qualified shipper will verify that the outside of the inner packaging is marked "Radioactive."

The qualified shipper will verify that the excepted packages prepared for shipment under the provisions of 49 CFR 173.421 have a notice enclosed, or shown on the outside of the package, that reads, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific QAPP.

7.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Survey documentation/radiation screening results (if shipping from DOE or radiological sites)
- Orientation labels
- Excepted quantities label
- Consignor/consignee labels

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7.4 Packaging of Limited-Quantity Radioactive Samples

The following steps are to be followed when packaging limited-quantity sample shipments:

1. The cooler is to be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
2. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
3. All sample containers will be properly labeled and the label protected with waterproof tape before sampling. At a minimum the label must contain:

<ul style="list-style-type: none"> ▪ Project name ▪ Project number ▪ Date and time of sample collection 	<ul style="list-style-type: none"> ▪ Sample location ▪ Sample identification number ▪ Collector's initials
--	---
4. This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
5. Place sufficient amount of an absorbent, or approved packaging material, in the bottom of the cooler to absorb any leakage that may occur.
6. Place a garbage bag in the cooler.
7. Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
8. If required, place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
9. Seal the garbage bag by tying or taping.
10. Place a label marked Radioactive on the outside of the sealed bag.
11. Enclose a notice that includes the name of the consignor or consignee and the following statement: ***"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."***
12. Note that both DOT and IATA apply different limits to the quantity in the inside packing and in the outside packing.
13. The maximum weight of the package shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
14. Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
15. If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
16. If a cooler is used, wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
17. Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.

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18. Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
19. Affix package orientation labels on two opposite sides of the cooler/package.
20. Affix a completed Excepted Quantities label to the side of the cooler/package.
21. Secure any marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment. An example of the cooler labeling/markings is shown in Figure 2.

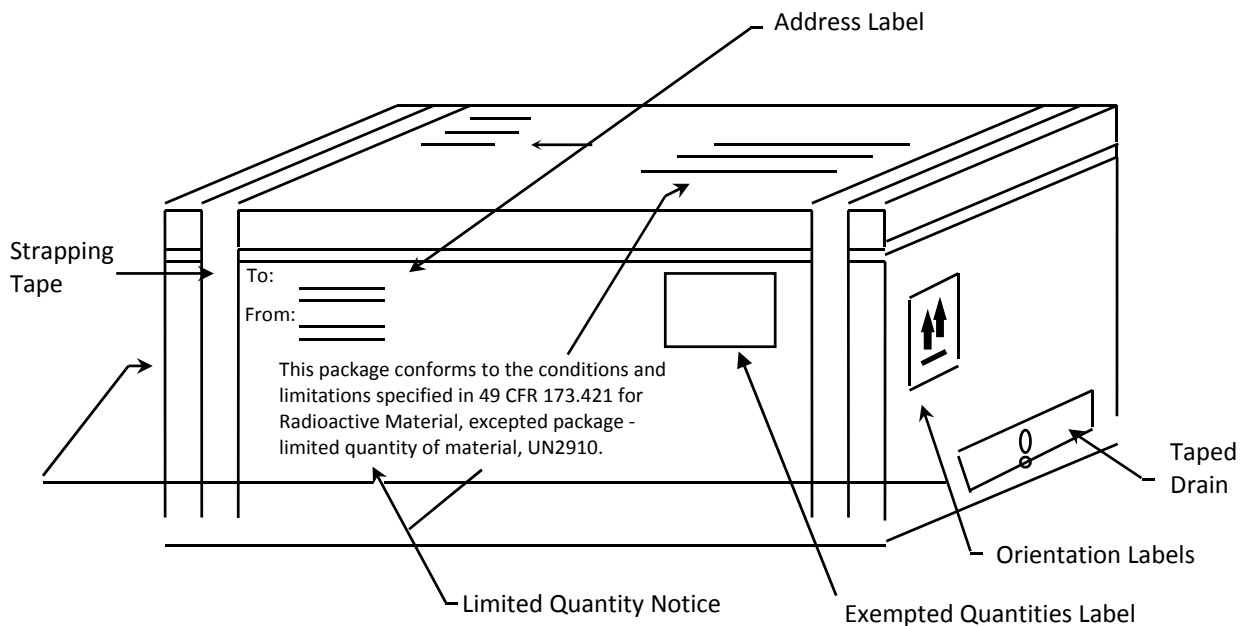
Note: No marking or labeling can be obscured by strapping or duct tape.

22. Complete the Shipment Quality Assurance Checklist (Appendix B).

Note: Except as provided in 49 CFR 173.426, the package will not contain more than 15 grams of ^{235}U .

Note: A declaration of dangerous goods is not required.

Figure 2
Radioactive Material – Limited-Quantity Cooler Marking Example



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8.0 References

U. S. Environmental Protection Agency. Region IV. May 2013, or current revision. *Field Branches Quality Management Plan*.

_____. August 2011 or current revision. Region IV. *Field Branches Quality Policy*.

_____. 2007 or current revision. *Sampler's Guide, Contract Laboratory Program, Guidance for Field Samplers*, EPA-540-R-07-06.

Title 49 Code of Federal Regulations, Department of Transportation. 2015 or current revision. *Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements*, 49 CFR 172.

Title 49 Code of Federal Regulations, Department of Transportation. 2015 or current revision. *Shippers - General Requirements for Shipments and Packagings*, 49 CFR 173.

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Appendix A

**Dangerous Goods and Hazardous Materials Inspection Checklist
for Shipping Limited-Quantity**

Sample Packaging

Yes	No	N/A	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The VOA vials are wrapped in bubble wrap and placed inside a zip-type bag.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The VOA vials are placed into a polyethylene bottle, filled with an absorbent, and tightly sealed.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The drain plug is taped inside and outside to ensure control of interior contents.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The samples have been placed inside garbage bags with sufficient bags of ice to preserve samples at 4°C.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The cooler weighs less than the 66-pound limit for limited-quantity shipment.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The garbage bag has been sealed with tape (or tied) to prevent movement during shipment.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The chain-of-custody has been secured to the interior of the cooler lid.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The cooler lid and sides have been taped to ensure a seal.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The custody seals have been placed on both the front and back hinges of the cooler, using waterproof tape.

Air Waybill Completion

Yes	No	N/A	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 1 has the shipper's name, company, and address; the account number, date, internal billing reference number; and the telephone number where the shipper can be reached.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 2 has the recipient's name and company along with a telephone number where they can be reached.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 3 has the Bill Sender box checked.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 4 has the Standard Overnight box checked.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 5 has the Deliver Weekday box checked.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Section 6 has the number of packages and their weights filled out. Was the total of all packages and their weights figured up and added at the bottom of Section 6?
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Under the Transport Details box, the Cargo Aircraft Only box is obliterated, leaving only the Passenger and Cargo Aircraft box.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Under the Shipment Type , the Radioactive box is obliterated, leaving only the Non-Radioactive box.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Under the Nature and Quantity of Dangerous Goods box, the Proper Shipping Name, Class or Division, UN or ID No., Packing Group, Subsidiary Risk, Quantity and Type of Packing, Packing Instructions, and Authorization have been filled out for the type of chemical being sent.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The Name, Place and Date, Signature, and Emergency Telephone Number appears at the bottom of the FedEx Airbill.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The statement "In accordance with IATA/ICAO" appears in the Additional Handling Information box.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The Emergency Contact Information at the bottom of the FedEx Airbill is truly someone who can respond any time of the day or night.

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<i>Proper Shipping Name</i>	<i>Class or Division</i>	<i>UN or ID No.</i>	<i>Packing Group</i>	<i>Sub Risk</i>	<i>Quantity</i>	<i>Packing Instruction</i>	<i>Authorization</i>
Hydrochloric Acid Solution	8	UN1789	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Nitric Acid Solution (with less than 20%)	8	UN2031	II		1 plastic box × 0.5 L	Y807	Ltd. Qty.
Sodium Hydroxide Solution	8	UN1824	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Sulfuric Acid Solution	8	UN2796	II		1 plastic box × 0.5 L	Y809	Ltd. Qty.
Methanol	3	UN1230	II		1 plastic box × 1 L	Y305	Ltd. Qty.

Sample Cooler Labeling

Yes	No	N/A	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The proper shipping name, UN number, and Ltd. Qty. appears on the shipping container.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The corresponding hazard labels are affixed on the shipping container; the labels are not obscured by tape.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The name and address of the shipper and receiver appear on the top and side of the shipping container.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	The air waybill is attached to the top of the shipping container.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Up Arrows have been attached to opposite sides of the shipping container.
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Packaging tape does not obscure markings or labeling.

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Appendix B**Shipment Quality Assurance Checklist**

Date: _____ Shipper: _____ Destination: _____

Item(s) Description: _____

Radionuclide(s): _____

Radiological Survey Results: surface _____ mrem/hr 1 meter _____

Instrument Used: Mfgr: _____ Model: _____

S/N: _____ Cal Date: _____

Limited-Quantity or Instrument and Article

- | Yes | No | |
|-----|-----|---|
| ___ | ___ | 1. Strong tight package (package that will not leak material during conditions normally incidental to transportation). |
| ___ | ___ | 2. Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr. |
| ___ | ___ | 3. Removable surface contamination less than 20 dpm/100 cm ² (alpha) and 1,000 dpm/100 cm ² (beta/gamma). |
| ___ | ___ | 4. Outside inner package bears the marking "Radioactive." |
| ___ | ___ | 5. Package contains less than 15 grams of ²³⁵ U (check yes if ²³⁵ U not present). |
| ___ | ___ | 6. Notice enclosed in or on the package that includes the consignor or consignee and the statement, "This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910." |
| ___ | ___ | 7. Activity less than that specified in 49 CFR 173.425. Permissible package limit:
Package Quantity: |
| ___ | ___ | 8. On all air shipments, the statement Radioactive Material, excepted package-limited quantity of material shall be noted on the air waybill. |

Qualified Shipper: _____ Signature: _____


Guide to Handling Investigation-Derived Waste

SOP 2-2

Revision: 8

Date: February 2015

Approved:



Signature

Technical Review:

Dave Sembrot

1.0 Objective

This technical standard operating procedure (SOP) presents guidance for the management of investigation-derived waste (IDW). The primary objectives for managing IDW during field activities include:

- Leaving the site in no worse condition than existed before field activities
- Removing wastes that pose an immediate threat to human health or the environment
- Proper handling of onsite wastes that do not require offsite disposal or extended aboveground containerization
- Complying with federal, state, local, and facility applicable or relevant and appropriate requirements (ARARs)
- Careful planning and coordination of IDW management options
- Minimizing the quantity of IDW

2.0 Background

2.1 Definitions

Hazardous Waste - Discarded material that is regulated listed waste, or waste that exhibits ignitability, corrosivity, reactivity, or toxicity as defined in 40 CFR 261.3 or state regulations.

Investigation-Derived Wastes - Discarded materials resulting from field activities such as sampling, surveying, drilling, excavation, and decontamination processes that, in present form, possess no inherent value or additional usefulness without treatment. Wastes may be solid, sludge, liquid, gaseous, or multiphase materials that may be classified as hazardous or nonhazardous.

Mixed Waste - Any material that has been classified as both hazardous and radioactive.

Radioactive Wastes - Discarded materials that are contaminated with radioactive constituents with specific activities in concentrations greater than the latest regulatory criteria (i.e., 10 CFR 20).

Treatment, Storage, and Disposal Facility (TSDF) - Permitted facilities that accept hazardous waste shipments for further treatment, storage, and/or disposal. These facilities must be permitted by the U. S. Environmental Protection Agency (EPA) and appropriate state and local agencies.

Aqueous liquid – a water based polar solution with a specific gravity at or near 1. Light non-aqueous phase liquids, also known as (a.k.a) LNAPL (non-polar), such as oils, typically float on aqueous (polar) solutions (or pure water). Dense non-aqueous phase liquids (a.k.a. DNAPL), such as chlorinated organic solvents or PCB containing oils, sink in aqueous based liquids.

2.2 Discussion

Field investigation activities result in the generation of waste materials that may be characterized as hazardous or radioactive. IDWs may include drilling muds, cuttings, and purge water from test pit and well installation; purge water, soil, and other materials from collection of samples; residues from testing of treatment technologies and pump and treat systems; personal protective equipment (PPE); solutions (aqueous or otherwise) used to decontaminate nondisposable protective clothing and equipment; and other wastes or supplies used in sampling and testing potentially hazardous or radiologically contaminated material.

Note: The client's representatives may not be aware of all potential contaminants. The management of IDW must comply with applicable regulatory requirements.

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3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that all IDW procedures are conducted in accordance with this SOP. The site manager is also responsible for ensuring that handling of IDW is in accordance with site-specific requirements.

Project Manager - The project manager is responsible for identifying site-specific requirements for the disposal of IDW in accordance with federal, state, and/or facility requirements.

Field Crew Members - Field crew members are responsible for implementing this SOP and communicating any unusual or unplanned condition to the project manager's attention.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/project specific quality assurance plan.

4.0 Required Equipment

Equipment required for IDW containment will vary according to site-specific/client requirements. Management decisions concerning the necessary equipment required shall consider: containment method, sampling, labeling, maneuvering, and storage (if applicable). Equipment must be onsite and inspected before commencing work.

The selection of the container type and size for containerizing IDW must consider:

- waste/contaminant segregation (i.e. do not mix hazardous and non-hazardous wastes or incompatible materials),
- efficiency/ability to move the containerized waste (i.e. size of equipment needed vs. accessibility and bulk vs. individual containers),
- cost of storage, (i.e. rental vs. purchase)
- transportation and disposal of the material in the containers selected.

4.1 IDW Containment Devices

The appropriate containment device (drums, tanks, etc.) will depend on site- or client-specific requirements and the ultimate disposition of the IDW. Typical IDW containment devices can include:

- Plastic sheeting (polyethylene) with a minimum thickness of 20 micrometers
- Department of Transportation (DOT)-approved steel containers
- Polyethylene or steel bulk storage tanks

Containment of IDW shall be segregated by waste type (i.e., solid or liquid, corrosive or flammable, etc.) and source location. Volume of the appropriate containment device will depend on site-specific requirements.

4.2 IDW Container Labeling

A "Waste Container" or "IDW Container" label or indelible marking shall be applied to each container. Labeling or marking requirements for onsite IDW not expected to be transported offsite are as detailed below.

- Labels and markings must contain the following information: project name, generation date, location of waste origin, container identification number, sample number (if applicable), and contents (drill cuttings, purge water, PPE, etc.).
- Each label or marking will be applied to the upper one-third of the container at least twice, on opposite sides.
- Containers that are 5 gallons or less may only require one label or set of markings.
- Labels or markings will be positioned on a smooth part of the container. The label must not be affixed across container bungs, seams, ridges, or dents.
- Labels must be constructed of a weather-resistive material with markings made with a permanent marker or paint pen and capable of enduring the expected weather conditions. If markings are used, the color must be easily distinguishable from the container color.
- Labels will be secured in a manner to ensure that they remain affixed to the container.

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Labeling or marking requirements for IDW expected to be transported offsite must be in accordance with the requirements of 49 CFR 172.

4.3 IDW Container Movement

Staging areas for IDW containers shall be predetermined and in accordance with site-specific and/or client requirements. Arrangements shall be made before field mobilization as to the methods and personnel required to safely transport IDW containers to the staging area. Transportation of IDW containers offsite via a public roadway is prohibited unless 49 CFR 172 requirements are met.

4.4 IDW Container Storage

Containerized IDW awaiting results of pending chemical analysis or further onsite treatment shall be staged on site. Staging areas and bulk storage procedures are to be determined according to site-specific requirements. Containers are to be stored in such a fashion that the labels can be easily read. A secondary/spill container must be provided for liquid IDW storage and as appropriate for solid IDW storage (e.g., steel drums shall not be stored in direct contact with the ground).

5.0 Procedures

The three general options for managing IDW are: (1) collection and onsite disposal, (2) collection for offsite disposal, and (3) collection and interim management. Attachment 1 summarizes media-specific information on generation processes and management options. The option selected shall take into account the following factors:

- Type (soil, sludge, liquid, debris), quantity, and source of IDW
- Risk posed by managing the IDW onsite
- Compliance with regulatory requirements
- IDW minimization and consistency with the IDW remedy and the site remedy

In all cases the client shall approve the plans for IDW. Formal plans for the management of IDW must be prepared as part of a work plan or separate document.

5.1 Collection and Onsite Disposal

5.1.1 Soil/Sludge/Sediment

The options for handling soil/sludge/sediment IDW are:

1. Return IDW to boring, pit, or source immediately after generation as long as returning the media to these areas will not increase site risks (e.g., so that "clean" areas are not contaminated, the IDW material will not be replaced at a greater depth, or in a different area than from where it was originally obtained).
2. Spread IDW around boring, pit, or source within the area of contamination (AOC) as long as returning the media to these areas will not increase site risks (e.g., direct contact with surficial contamination).
3. Consolidate IDW in a pit within the AOC as long as returning the media to these areas will not increase site risks (e.g., the contaminated soil will not be replaced at a greater depth than where it was originally so that it will not contaminate "clean" areas).
4. Send to onsite TSDF. This option may require results of laboratory analysis before treatment/disposal.

Note: These options may require client and/or regulatory approval.

5.1.2 Aqueous Liquids

The options for handling aqueous liquid IDW are:

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1. Discharge to surface water, only when IDW is not contaminated, and with written client approval.
2. Discharge to ground surface close to the well from which it was extracted, only if soil contaminants will not be mobilized in the process and the action will not contaminate clean areas. If IDW from the sampling of background upgradient wells is not a community concern or associated with soil contamination, this presumably uncontaminated IDW may be released on the ground around the well with written client approval.
3. Discharge to sanitary sewer, only when IDW is not contaminated and with written client approval.
4. Send to onsite treatment/disposal facility, with facility acceptance and written client approval.

Note: These options may require results of laboratory analysis to obtain client and/or regulatory approval.

5. When small amounts (i.e., less than 5 gallons) of used decontamination fluids are generated during site characterization activities (e.g., during soil sampling using direct push technology methods), the fluids may be allowed to evaporate by spreading them on an asphalted surface, or allowing for evaporation from an open bucket.

5.1.3 Disposable PPE

The options for handling disposable PPE are:

1. Double-bag contents in nontransparent trash bags and place in onsite industrial dumpster, only if PPE is not contaminated.
2. Containerize, label, and send to onsite TSDF. This may require results of laboratory analysis before treatment/disposal.

5.2 Collection for Offsite Disposal

Before sending IDW to an offsite TSDF or to a publicly owned treatment works (POTW), laboratory analysis may be required. Manifests are required to accompany any IDW determined to be hazardous. In some instances, a bill of lading can be used for nonhazardous solid IDW (i.e., wooden pallets, large quantities of plastic sheeting). Arrangements must be made with the client responsible for the site to sign as generator on any waste profile and all manifests or bill of ladings; it is CDM Smith's policy not to sign any waste profile or manifest. The TSDF and transporter must be permitted for the respective wastes. Nonbulk containers (e.g., drums) must have a DOT-approved label adhered to the container and all required associated placard stickers before leaving for an offsite TSDF. These labels must include information as required in 49 CFR 172. Bulk containers (i.e., rolloffs, tanks) do not require container specific labels for transporting offsite, but must include appropriate placards as required in 49 CFR 172.

5.2.1 Soil/Sludge/Sediment

When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., drummed, covered in a waste pile) or returned to its source until final disposal. The management option selected shall take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.2 Aqueous Liquids

When the final site remedy requires offsite treatment and disposal, the IDW may be stored (e.g., mobile tanks or drums with appropriate secondary containment) until final disposal. The management option selected shall take into account the potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

5.2.3 Disposable PPE

When the final site remedy requires offsite treatment and disposal, the IDW may be containerized and stored. The management option selected shall take into account potential for increased risks, applicable regulations, and other relevant site-specific factors (e.g., weather, storage space, and public concern/perceptions).

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5.3 Collection and Interim Management

All interim measures must be approved by the client and regulatory agencies.

1. Storing IDW onsite until the final action may be practical in the following situations:
 - Returning wastes (especially sludges and soils) to their onsite source area would require reexcavation for disposal as determined for the final site remedy.
 - Interim storage in containers may be necessary to provide adequate protection to human health and the environment.
 - Offsite disposal options may trigger land disposal regulations under the Resource Conservation and Recovery Act (RCRA). Storing IDW until the final disposal of all wastes from the site will eliminate the need to address this issue more than once.
 - Interim storage may be necessary to provide time for sampling and analysis.
2. Segregate and containerize all waste for future treatment and/or disposal.
 - Containment options for soil/sludge/sediment may include drums or covered waste piles in AOC.
 - Containment options for aqueous liquids may include mobile tanks or drums.
 - Containment options for PPE may include drums or roll-off boxes.

6.0 Restrictions/Limitations

Site managers shall determine the most appropriate disposal option for aqueous liquids on a site-specific basis. Parameters to consider, especially when determining the level of protection, include the volume of IDW, the contaminants present in the aqueous liquid, the nature of contaminants present in the site soil, and whether groundwater or surface water is a drinking water supply, and if obtained from contaminated groundwater, whether the plume is contained or migrating. Special disposal/handling may be needed for drilling fluids because they may contain significant solid components and therefore may need to be handled, treated, disposed as non-liquid wastes.

Disposable sampling materials, disposable PPE, decontamination fluids, etc. will always be managed on a site-specific basis. Under no circumstances shall these types of materials be stored in a site office or warehouse.

7.0 References

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Attachment 1 IDW Management Options

<i>Type of IDW</i>	<i>Generation Processes</i>	<i>Management Options</i>
Soil	<ul style="list-style-type: none"> Well/Test pit installations Borehole drilling Soil sampling 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Return to boring, pit, or source immediately after generation Spread around boring, pit, or source within the AOC Consolidate in a pit (within the AOC) Send to onsite TSDF <p>Offsite Disposal</p> <ul style="list-style-type: none"> Client to send to offsite TSDF <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal
Sludge/Sediment	<ul style="list-style-type: none"> Sludge pit/sediment sampling 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Return to pit or source immediately after generation Send to onsite TSDF <p>Offsite Disposal</p> <ul style="list-style-type: none"> Send to offsite TSDF* <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal
Aqueous Liquids (groundwater, surface water, drilling fluids, wastewater)	<ul style="list-style-type: none"> Well installation/development Well purging during sampling Groundwater discharge during pump tests Surface water sampling Wastewater sampling 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Pour onto ground close to well (nonhazardous waste) Discharge to sewer Send to onsite TSDF <p>Offsite Disposal</p> <ul style="list-style-type: none"> Send to offsite TSDF* Client to send to publicly owned treatment works (POTW) <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal
Decontamination Fluids	<ul style="list-style-type: none"> Decontamination of PPE and equipment 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Send to onsite TSDF Evaporate (for small amounts of low contamination organic fluids) Discharge to ground surface <p>Offsite Disposal</p> <ul style="list-style-type: none"> Send to offsite TSDF* Discharge to sewer <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal
Disposable PPE and Sampling Equipment	<ul style="list-style-type: none"> Sampling procedures or other onsite activities 	<p>Onsite Disposal</p> <ul style="list-style-type: none"> Place in onsite industrial dumpster Send to onsite TSDF <p>Offsite Disposal</p> <ul style="list-style-type: none"> Send to offsite TSDF* <p>Interim Management</p> <ul style="list-style-type: none"> Store for future treatment and/or disposal

* Client must sign waste profile, manifest, etc. for any waste sent offsite.

Adapted from U. S. Environmental Protection Agency, *Guide to Management of Investigation-Derived Wastes*, 9345-03FS, January 1992.


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Approved:



Signature

Technical Review:

Stuart Barden

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to define the requirements for collecting soil, soil gas, groundwater, and pneumatic slug test data using the Geoprobe® sampling system. Geoprobe is a trade name proprietary to Geoprobe Systems of Salina, Kansas.

2.0 Background**2.1 Definitions**

Geoprobe - A hydraulically-operated hammer device installed on the back of a van, pickup truck, or tracked vehicle used to advance a hollow-stem rod into the soil for the purpose of collecting soil, soil gas, or groundwater samples.

Probe-Drive Sampler - A sampling device, similar to a split-spoon sampler, used to collect soil samples with a Geoprobe rig. Two primary types of soil samplers are available: Dual Tube (DT), and Macro-Core® (MC) sampler (with a PVC liner). Sample core lengths range from 24 to 72-inches and diameters range from 1.125 to 4-inches. Search Geoprobe Systems website for probe rods and DT and MC samplers for additional specific sizes available.

Extension Rod - Stainless steel rod used to remove stop-pin and drive-point assembly.

Extension Rod Coupler - Stainless steel connector used to join sections of extension rods.

Drive Point - Solid steel retractable point used to advance sample collection device to the required sample depth.

Probe Rod - Hollow, flush-threaded, steel rod similar to a drill rod.

Stop-Pin - Steel plug that threads into the top of the drive cap to hold the drive point in place during advancement of the probe rods.

Drive Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when advancing the probe rods with the hydraulic hammer.

Pull Cap - Threaded, hardened-steel top cap that attaches to the top of the probe rod; used when retracting the probe rods.

Extruder Rack and Piston - A device used in conjunction with the Geoprobe to force soil sample volume out of the sample tube.

Screen Point Groundwater Sampler - A groundwater sampling device designed for use with the Geoprobe consisting of a well screen encased in a perforated stainless steel sleeve.

Mill-Slotted Well Rod and Point - A groundwater sampling device designed for use with the Geoprobe consisting of a Geoprobe probe rod with 15-mil slots, each 5 cm long by 0.05 cm wide (2 inches long x 0.020 inches wide).

Post-Run Tubing System (PRT) - The Geoprobe soil vapor sampling system uses disposable polyethylene or Teflon tubing (inserted into the probe rods at the desired sampling depth) and a vacuum.

Expendable Drive Point - Solid steel point attached to the end of the screen point groundwater sampler and PRT expendable point holder.

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Membrane Interface Probe (MIP) - A screening tool with semi-quantitative capabilities acting as an interface between the volatile contaminants in the subsurface and gas phase detectors at the surface. The membrane is placed in a heated block attached to the probe. Heating the block accelerates diffusion of the contaminant through the membrane into the carrier gas, which flows up hole to the detectors.

2.2 Associated Procedures

- SOP 1-2, *Sample Custody*
- SOP 2-1, *Packaging and Shipping Environmental Samples*
- SOP 1-5, *Groundwater Sampling Using a Bailer*
- SOP 1-6, *Water Level Measurements*
- SOP 2-1, *Packaging and Shipping Environmental Samples*
- SOP 4-1, *Field Logbook Content and Control*
- SOP 4-3, *Well Development and Purging*
- SOP 4-5, *Field Equipment Decontamination*

2.3 Discussion

The Geoprobe unit consists of a hydraulically-operated hammer device that can be mounted on the back of a van, a pickup truck or track-mounted (Figure 1). The Geoprobe system hydraulically advances small-diameter, hollow rods to the desired sampling depth. The specific type of Geoprobe sampling equipment for soil, soil gas, and groundwater collection is then employed.

The use of Geoprobe technology may be a cost-effective alternative to using conventional drilling techniques for collecting subsurface soil, soil gas, and groundwater samples depending on the site-specific geologic and hydrogeologic conditions and sample requirements. The Geoprobe system is generally used to gather screening-level data. The site-specific sampling plans must consider such factors as soil types, presence of cobbles, depth to groundwater, quantity and depth of samples, site access and topography, data quality objectives (DQOs), analytical requirements, and waste handling and disposal requirements before selecting the use of the Geoprobe.

Advantages of using the Geoprobe Systems include:

- Areas usually considered inaccessible by drill rigs because of overhead wires, steep slopes, size constraints, etc., may be accessed with a van-, pickup truck-, or track-mounted Geoprobe.
- Investigation-derived wastes such as soil cuttings and purge water are minimized with the Geoprobe due to its small diameter rods and its displacement of soil horizontally, not vertically.
- Pneumatic slug testing is also an option when using the SP16 groundwater sampler. Analyses of these tests will yield hydraulic conductivity values for the surrounding aquifer materials.

A Geoprobe membrane interface probe (MIP) and integrated electrical conductivity (EC) dipole combination can be deployed with direct push methods to discriminate variation in grain size and volatile organic contaminants (VOCs). As a result, lithologic changes and distribution of contaminants (chlorinated and nonchlorinated) can be determined in the subsurface.

Cost savings over conventional drilling techniques may be realized. The Geoprobe is rented/leased on a daily, weekly, or monthly basis for a fixed price as opposed to drilling subcontractors who are generally compensated based on the footage drilled. For shallow probing, the Geoprobe may be hand- operated by field personnel rather than subcontractors. A cost evaluation based on project-specific requirements and site conditions shall be conducted to determine the most cost-effective method for a particular project.

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Two people are required to operate the Geoprobe and conduct sampling and recordkeeping activities. Safety considerations shall be addressed when operating the Geoprobe. A safety hazard is present whenever the Geoprobe is operated. The hydraulic system operates with a fluid pressure of over 2,000 pounds per square inch (psi). A leaking hose may produce a stream of hydraulic fluid with sufficient pressure to penetrate skin. Therefore, periodic checks of the hydraulic lines and hoses shall be conducted to ensure they are in good condition and connections are tight. Do not attempt to repair or tighten hoses with the engine running and the system under pressure. Use paper or cardboard to check for leaks.

3.0 General Responsibilities

Field Team Leader (FTL) - The field team leader (FTL) is responsible for ensuring that sampling efforts are conducted in accordance with this procedure, associated SOPs, and the site-specific plans.

Sampling Personnel - Field team members are responsible for conducting Geoprobe sampling events in accordance with this procedure, all associated SOPs, and requirements as described in the site-specific plans.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment**General**

- Site-specific plans
- Field logbook, chain-of-custody forms, other forms for documenting sample shipment
- Indelible black or blue ink pens and markers
- Sample containers with labels and preservatives
- Insulated coolers
- Bagged ice or "blue ice"
- Plastic zip-top bags
- Waterproof sealing tape
- Temperature, conductivity, pH, dissolved oxygen, and turbidity meters (with clean beakers or other appropriate containers), as required by the site-specific plans
- Monitoring/screening instruments as required by the site-specific health and safety plan or sampling plan
- Decontamination supplies, as required by SOP 4-5
- Personal protective equipment (PPE), as required by the site-specific health and safety plan (at a minimum, hard hat, steel-toed shoes, safety glasses, and hearing protection are required)
- Latex or appropriate gloves
- Geoprobe rig (van, truck, or track-mounted) with the following:
 - Probe rods (1 to 5-foot [ft]) lengths
 - Extension rods (1 to 5-ft) lengths, couplers, and handle
 - Piston stop-pins (two each per rig, minimum)
 - Drive caps and pull caps (two each per rig, minimum)
 - Carbide-tipped drill bit for working in concrete- or asphalt-covered areas
 - O-rings

Geoprobe Soil Sampling Equipment

- Extruder rack and piston (i.e., if soil is to be extruded into a sample container)
- Assembled DT or MC soil samplers (The stainless steel sample tubes or PVC liners from these samplers may be individually sealed and shipped directly to the laboratory, as indicated in site-specific plans)
- Refer to the Geoprobe Systems website for specific parts and accessories for each sampler

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Geoprobe Soil Gas Sampling Equipment

- Expendable drive points (one each per sample location, plus spares)
- Extension rod ram
- 10 millimeter (mm) (3/8-inch) polyethylene (Teflon-lined) tubing and PRT adapter
- Vacuum or sampling system
- Syringe
- PRT adapter
- PRT expendable point holder

Geoprobe Groundwater Sampling Equipment

- Expendable drive points (one each per sample location, plus spares)
- Mill-slotted well point or screen point groundwater sampler assemblies
- Extension rod ram
- 10-mm (3/8-inch) polyethylene or Teflon-lined tubing
- Check valves (if using Waterra system)
- Peristaltic pump (limited to shallow depths)
- Mini-bailer (with thin nylon line)

5.0 Procedures

Procedures common to all three sampling methods are discussed below.

Before sampling:

- Review site-specific health and safety plan and project plans before initiating sampling activity.
- Arrange utility clearance.
- Decontaminate all Geoprobe equipment according to SOP 4-5, *Field Equipment Decontamination*.
- Don the appropriate PPE as dictated by the site-specific health and safety plan.
- If the sampling site is in a concrete- or asphalt-covered area, drill a hole using the rotary function and a specially designed carbide-tipped drill bit of the diameter appropriate for the selected sampler diameter. Otherwise, the area needs to be cleared of heavy underbrush and immediate overhead obstructions.

After sampling is completed:

- Thread the pull cap onto the top probe rod and retract the probe rods.
- Seal the borehole with sand, neat cement, or bentonite grout, if necessary.
- Record all appropriate data in the field logbook and on the chain-of-custody forms as outlined in SOP 4-1, *Field Logbook Content and Control* and SOP 2-1, *Packaging and Shipping Environmental Samples*.
- Decontaminate the sampling equipment according to SOP 4-5, *Field Equipment Decontamination*.

5.1 Soil Sampling**Assembly**

1. Assemble the sampling device as follows:

- Screw the cutting shoe to the bottom end of the sample tube, unless using standard probe drive sampler which has a built-in cutting edge.
- Screw the piston tip onto the piston rod.

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- Screw the drive head onto the top end of the sample tube.
- If using Teflon liner, insert liner into sample tube.
- Slide the piston rod into the sample tube, leaving the piston tip sticking out of the bottom end of the sample tube.
- Screw the piston stop-pin onto the top end of the piston rod in a counter-clockwise direction.

2. Attach the assembled sampler onto the leading probe rod. A 30-cm (12-inch) probe rod is recommended to start the DT and MC samplers.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler. Replace the 30-cm (12-inch) rod with rod appropriate for the stroke of the rig as soon as the top of the sampler is driven to within 15 cm (6 inches) of the ground surface.
4. Advance the sampler to the interval to be sampled using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.

Stop-Pin Removal

5. Move the probe unit back from the top of the probe rods and remove the drive cap.
6. Lower the extension rods into the inside diameter of the probe rods using extension rod couplers to join the extension rods.
7. Attach the extension rod handle to the top extension rod and rotate the handle clockwise until the leading extension rod is screwed into the piston stop-pin. Continue to rotate the handle clockwise until the stop-pin disengages from the drive head.
8. Remove the extension rods and attached piston stop-pin from the probe rods.

Interval Sampling

9. Replace the drive cap, mark the top probe rod with a marker or tape at a distance above the ground equal to the length of the sample tube.
10. Advance the probe rods using the hydraulic hammer the length of the sample tube.
11. Replace the drive cap with the pull cap and retract the probe rod(s). Secure the rod(s) with a clamp or by hand during removal so they do not fall back down the resulting borehole.
12. Detach the sampler from the lead probe rod, verifying that sufficient sample volume was recovered (Note: The length of sample contained within the tube is approximately equal to the length of exposed piston rod).
13. Disassemble the sampler. If the sample is to be analyzed for VOCs, then the sample tube or liner shall be sealed immediately by placing a Teflon septa over the ends and covering them with plastic caps.
14. If samples do not require VOC analysis, they may be extruded from the sampler and transferred to the sample jars specified in the site-specific plans or SOP 2-1, Packaging and Shipping Environmental Samples. Samples can be extruded by one of two methods:
 - Using the Geoprobe rig and the extruder rack (Figure 2), position the extruder rack on the foot of the Geoprobe derrick; insert the sample tube into the extruder rack with cutting end up; and position the extruder piston, pushing the sample out of the sample tube using the “probe” function. Catch the sample as it exits beneath the extruder in a sample jar or stainless steel mixing bowl.

Note: Samples to be collected for VOCs will be collected directly from the sample tube into the sample jars.

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- Lightly tap the side of the sample tube with a hammer while also lightly pushing the Piston Rod.

15. Label the sample liner or sample jars as required, securing the label by covering it with a piece of clear, waterproof tape.
16. Homogenize the sample in a stainless steel bowl with a stainless steel spoon or spatula. Transfer the sample from the bowl to the sample container.
17. Clean the outside of the sample jars and place individual samples into sealable bags and seal the closure.
18. Place samples in a cooler containing ice according to SOP 2-1, Packaging and Shipping Environmental Samples.

Continuous Sampling

The DT21/22, DT325/35, DT45, DT60, MC5, and MC7 are direct push systems for collecting continuous core samples of unconsolidated materials from within sealed probe rods. Samples are collected and retrieved within a liner that is threaded onto the leading end of a string of Geoprobe rods inserted to the bottom of the outer casing.

5.2 Soil Gas Sampling**Assembly**

1. Assemble the sampling device as follows (Figure 3):
 - Test fit the adapter with the PRT expendable point holder or retractable point holder to ensure that threads are compatible and fit together smoothly.
 - Attach the PRT adapter to flexible tubing equal in length to the depth of sampling, with some additional tubing for sampling activities.
 - Secure the PRT adapter with a length of electrical tape and check the condition of the O-ring attached to the end of the PRT adapter.
 - Screw the PRT expendable point holder into the bottom of the lead probe rod.
 - Attach an expendable drive point to the bottom of the PRT expendable point holder.
2. Attach the assembled sampler onto the leading probe rod. A 30-cm (12-inch) probe rod is recommended to start the standard and large bore samplers.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler. Replace the 30-cm (12-inch) rod with rod appropriate for the stroke of the rig as soon as the top of the sampler is driven to within 15 cm (6 inches) of the ground surface.
4. Advance the sampler to 30 cm (1 ft) past the interval to be sampled using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.
5. Connect the out-of-hole tubing to a vacuum or sampling system. A short section of inert silicon tubing may be connected to the end of the out-of-hole tubing so that a sample can be collected with a glass gas chromatograph (GC) syringe.
6. Start the vacuum or sampling system and allow the system to operate for 2 to 3 minutes to ensure that a sufficient volume of air has been run through the tubing. Document the depth, vacuum pressure, and purge duration in logbook.

Note: Make sure the vacuum evacuation pump is able to pull vapors from the formation. Excessive vacuum may occur in clay/clayey units resulting in insufficient sample volume.

7. Collect sample using the method specified in the site-specific plan.

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8. Label all sample containers as required, securing the label by covering it with a piece of clear, waterproof tape.
9. Remove the tubing from the probe rods. Dispose of the tubing or set it aside for decontamination.
10. Remove probe rod(s) from hole. Leave tubing in place for longer term monitoring.

Other Vapor Sampling Options

1. The Vacuum/Volume System is a combined pump and tank system. In typical operation this tank is pumped down with the system vacuum pump. The vacuum pump is then shut off and the tank is opened to the soil gas sampling train. By measuring the change in pressure in the tank, the soil gas sampling can be performed at the same pressure at each sampling point, improving the comparability of samples.
2. Vapor Implants are permanent sampling points inserted into the subsurface for ongoing monitoring. Implants are stainless steel screens that can be inserted down the bore of a probe rod and anchored at depth. As probe rods are removed from the hole, the implant and associated tubing remain firmly anchored at the bottom and available for ongoing sampling.

5.3 Groundwater Sampling**Assembly**

1. Assemble the screen point groundwater sampler as shown on Figure 4 and described below (see Geoprobe Systems website, Groundwater Assessment Tools):
 - Push the screen insert and plug into the screen sleeve from the bottom. The bottom end has one drain hole.
 - Push the screen connector over the top end of the screen sleeve and push the screen connector pin into place. The pin must be held in place as it has a loose fit.
 - Insert the screen sleeve, screen connector first, into one end of the sampler sheath.
 - Slide the drive point seat over the end of the screen assembly that protrudes from the sampler sheath. Thread it in until tight using a 22-mm (7/8-inch) wrench.
 - Push the screen assembly just far enough into the sampler sheath that an expendable drive point can be pushed into place in the drive seat.
 - Screw the groundwater drive head with the O-ring end first into the open end of the sampler sheath.
 - O-rings are installed at various critical places in the sampler assembly. Ensure that all O-rings have not been worn and that the connections made at O-ring locations are tight.
 - The mill-slotted well point does not need any assembly.
2. Attach the mill-slotted well point, or screen point groundwater sampler, onto the leading probe rod. A 30-cm (12-inch) probe rod is recommended to start either groundwater sampler.

Probing

3. Thread the drive cap onto the top of the probe rod and advance the sampler using either the hydraulic hammer or hydraulic probe mechanism on the Geoprobe rig. Replace the 30-cm (12-inch) rod with rod appropriate for the stroke of the rig as soon as the top of the sampler is driven to within 15 cm (6 inches) of the ground surface.
4. Advance the sampler to the interval to be sampled using the hydraulic hammer. Add additional probe rods as necessary to reach the specified sampling depth.

Developing and Sampling

6. Move the probe unit back from the top of the probe rods and remove the drive cap.

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7. The next step varies depending on the type of sampler being used:
 - Mill-slotted well point - measure and record the water level, allowing time for the water level to reach equilibrium.
 - Screen point groundwater sampler - attach the pull cap to the top probe rod, retract the probe rods approximately 60 cm (2 ft), push the screen into the formation using extension rods fitted with a ram, remove extension rods from the probe rods, and measure and record the water level, allowing time for the water level to reach equilibrium.
8. Surging and purging shall be conducted throughout the length of the exposed screen to properly develop the well point before sampling.
9. Label all sample containers as required, securing the label by covering it with a piece of clear, waterproof tape.
10. Collect groundwater samples using one of three methods (as outlined in site-specific plans) described below:
 - Collect sample from the inside diameter of the probe rods using a decontaminated mini-bailer. Follow SOP 1-5, Groundwater Sampling Using a Bailer.
 - Collect sample using a peristaltic pump and flexible tubing system.
 - Collect sample using a check valve (Waterra-type valve) attached to the bottom of 10-mm (3/8-inch) diameter tubing. The tubing is lowered into the probe rods below the top of the water table, check valve-end first. Water sample is collected through the tubing by rapidly oscillating the tubing up and down creating an inertial pump.
11. Clean the outside of the sample containers and place individual samples into sealable bags and seal closure.
12. Place samples in a cooler containing ice according to SOP 2-1, Packaging and Shipping Environmental Samples.

5.4 Pneumatic Slug Testing**Assembly**

1. Assemble the screen point groundwater sampler and the pneumatic manifold assembly as shown on Figure 5 (see Geoprobe Systems Instructional Bulletin No. MK3181).
2. Be sure to accurately document all well construction parameters and site geologic information:

<ul style="list-style-type: none"> ▪ Effective screen length (includes sand or filter pack) ▪ Height of water column in well ▪ Radius of filter pack ▪ Radius of transducer and cable (for wells 1-inch diameter or less) ▪ Depth of transducer below static water level ▪ Saturated thickness of the aquifer 	<ul style="list-style-type: none"> ▪ True screen length ▪ Screen radius ▪ Casing radius ▪ Static water level from a fixed reference point ▪ Total depth of well from a fixed reference point ▪ Initial head change
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3. Once the pneumatic head is in place, a vented pressure transducer assembly is installed. The transducer itself is inserted through the port on top of the pneumatic head and lowered into the well about 2-feet below the static water level and off the bottom of the well.
4. Let the transducer equilibrate to ambient groundwater temperature and then zero out the transducer.

Testing

5. Set up slug test data acquisition software and select preferred options (refer to Instructional Bulletin No. MK3087).
6. Close inlet and release valves and close the pressure regulator on the manifold assembly.

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7. Adjust zero setting on pressure gauge, if needed.
8. Operate foot pump to pressurize supply hose to approximately 30 to 40 psi.
9. Open inlet valve on pneumatic head.
10. Slowly open the pressure regulator. From the fully closed position it takes about five revolutions to begin opening the regulator. Observe the pressure gauge on the pneumatic head (scaled as inches of water). Let the pressure in the well head rise slowly to a few inches above the level desired for testing (e.g. if you want to initiate the slug test with H_0 of 10 inches let the gauge rise to about 12 inches).
11. Quickly close the inlet valve and allow the pressure observed from the transducer in the well head to return to equilibrium and stabilize. Record the stabilized gauge pressure. The readings shall return to the levels noted before pressurization was started.
12. Leak test the fittings on the pneumatic head and connection to the rods with a soapy fluid. Tighten fittings if necessary and retest. It is preferable to locate and correct any slow leaks before continuing with the slug test.
13. Once the transducer readout is back to equilibrium and stable, the slug test is ready to initiate. The slug test is initiated by opening the release valve as quickly as possible.
14. A very rapid initial drop in the transducer readout (head) shall be observed as the air pressure is released. Then the rise or recovery of the water level to the pre-test equilibrium level (baseline) will occur. Once the water level has returned to the pre-test level and is stable, the slug test is complete.
15. It is strongly recommended that at least three slug tests are run using different initial head values (H_0) to verify appropriate well performance and development. If there is significant deviation between the repeat tests, additional development of the well or sampler may be necessary.

Geoprobe Systems has designed a simple user-friendly software package and data logger that allows acquisition and filing of pneumatic transducer data on a laptop computer. The data files are stored in ASCII format for easy export to spreadsheet and data analysis programs. The selection and application of the appropriate data analysis methods is beyond the scope of this SOP for field techniques.

6.0 Restrictions/Limitations

Smaller diameter Geoprobe sampling systems are not designed for collecting large sample volumes, thereby limiting the number of analytical parameters. Soil sample recovery will be poor in soils. Production rates will vary substantially depending on sampling depths/intervals, subsurface conditions, and the platform used. However, a minimum of between 10 and 15 samples per day can be expected in most situations.

The most efficient sampling depth is limited by the geologic and hydrogeologic conditions. Practical, efficient sampling depths shall be limited to approximately 6 meters (20 feet) under most conditions. However, sampling depths in excess of 30 meters (100 feet) have been achieved in unconsolidated, homogeneous sandy soils using heavy duty platforms and MC5 tools. Attainable depths will be greatly reduced in more consolidated and indurated formations and in soils with gravel and cobbles.

The presence of gravel and cobbles in soils will likely damage soil sampling tubes and possibly probe rods, couplers, stop-pins, and other probing equipment. A sufficient supply of replaceable equipment shall be kept on site in the event of damage or breakdowns. Replacement may be at the project's - not the subcontractor's - expense. The Geoprobe Systems website shall be accessible onsite; Geoprobe Systems provides overnight deliveries. MIP tooling is expensive and more fragile than standard soil sampling tooling and may not be appropriate in dense formations or formations with substantial amounts of gravel and/or cobbles.

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Before conducting the Geoprobe sampling event, underground utilities and structures must be demarcated on the ground surface. The local utility companies must be notified at least 72 hours before the scheduled sampling event to allow sufficient time to locate and mark the utility lines. The selected sampling location shall be a safe distance from the demarcated utility. In some cases, records regarding utility locations may not exist. In any event, a good practice is to slowly push the probe rods the first few feet (rather than hammering) to ensure that no utilities, underground storage tanks, or other subsurface structures are present.

7.0 References

Department of Defense. *Environmental Field Sampling Handbook, Revision 1*. April 2013 or current revision.

Geoprobe® Systems. 2015. *Standard Operating Procedure*. < <http://geoprobe.com/literature/...> >.

U.S. Environmental Protection Agency, Region IV. *Science and Ecosystem Support Division, Operating Procedure SESDPROC-300-R3*. August 2014 or current revision.

Geoprobe® Sampling

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Figure 1
Geoprobe® Unit

BASICS

- HYDRAULICALLY POWERED PROBE OPERATES FROM HYDRAULIC SYSTEM DRIVEN FROM THE VEHICLE OR AN AUXILIARY ENGINE.
- REMOTE VEHICLE IGNITION ALLOWS OPERATORS TO START VEHICLE ENGINE FROM REAR COMPARTMENT.
- BELT DRIVEN HYDRAULIC PUMP SUPPLIES 10 GPM AT 2000 RPM, 2250 PSI OPERATING PRESSURE.
- PROBE UNIT FOLDS FOR TRANSPORT AND SETS UP AGAIN IN SECONDS.
- UTILIZES STATIC FORCE (WEIGHT OF VEHICLE) AND PERCUSSION TO ADVANCE PROBING TOOLS.
- POWERFUL 8 HP HYDRAULIC HAMMER DELIVERS OVER 1800 BLOWS PER MINUTE.
- HAMMER FEATURES 0-300 RPM LH DIRECTIONAL ROTARY FUNCTION FOR DRILLING SURFACE PAVEMENTS.
- PROBE HAS GREATER THAN 12,000 LBS. OF PULLING CAPACITY.
- DRIVES SMALL DIAMETER (1" O.D. - 1.6" O.D.) PROBING TOOLS TO DEPTHS LIMITED ONLY BY SOIL TYPE AND DEPTH TO BEDROCK, TYPICALLY TO OVER THIRTY FEET.

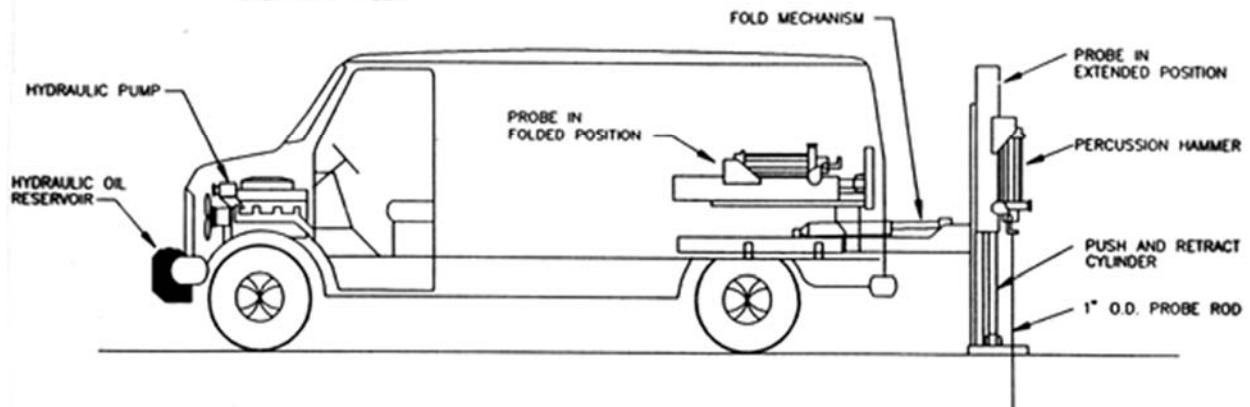


Figure 2
Sample Extruder Rack

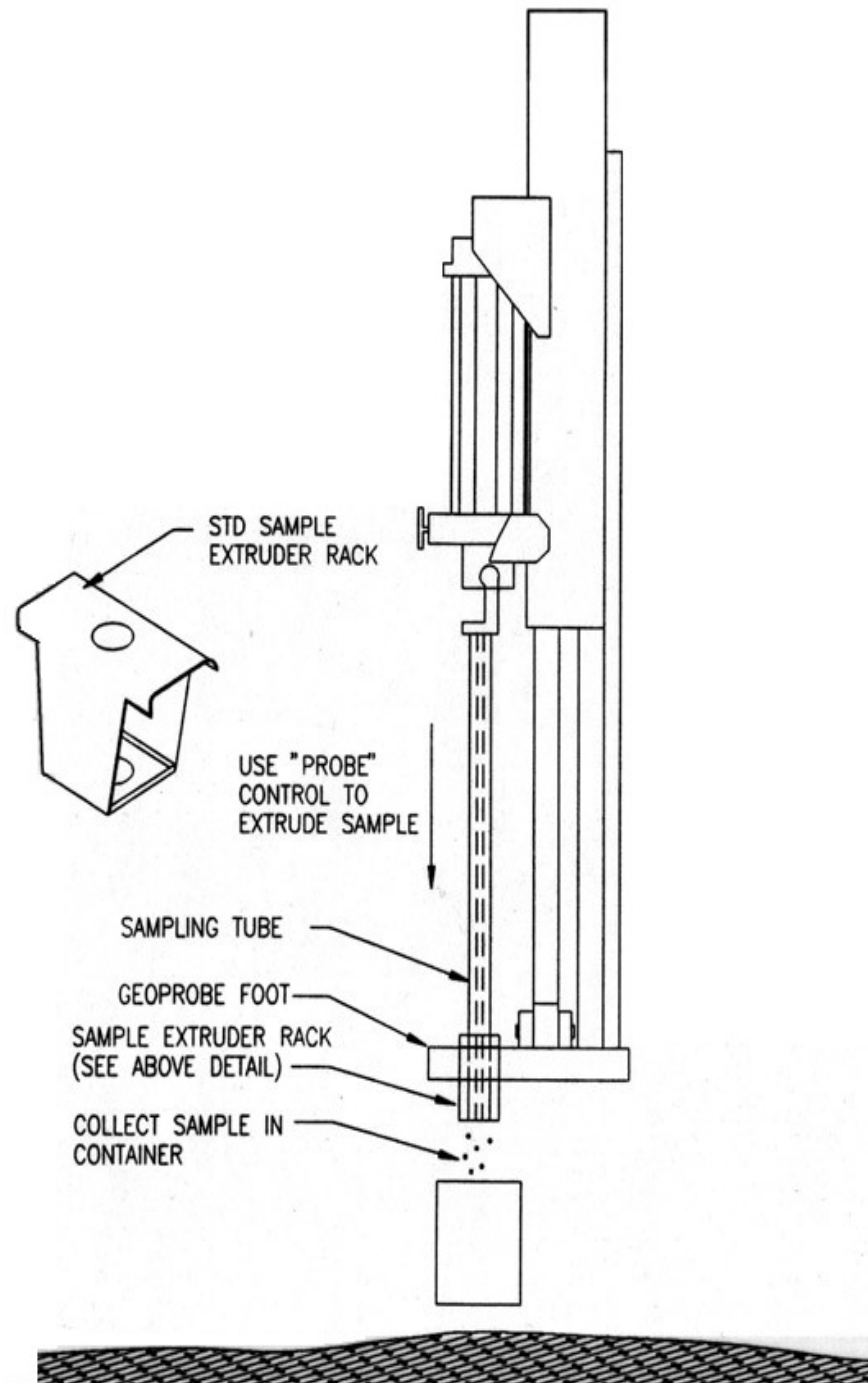
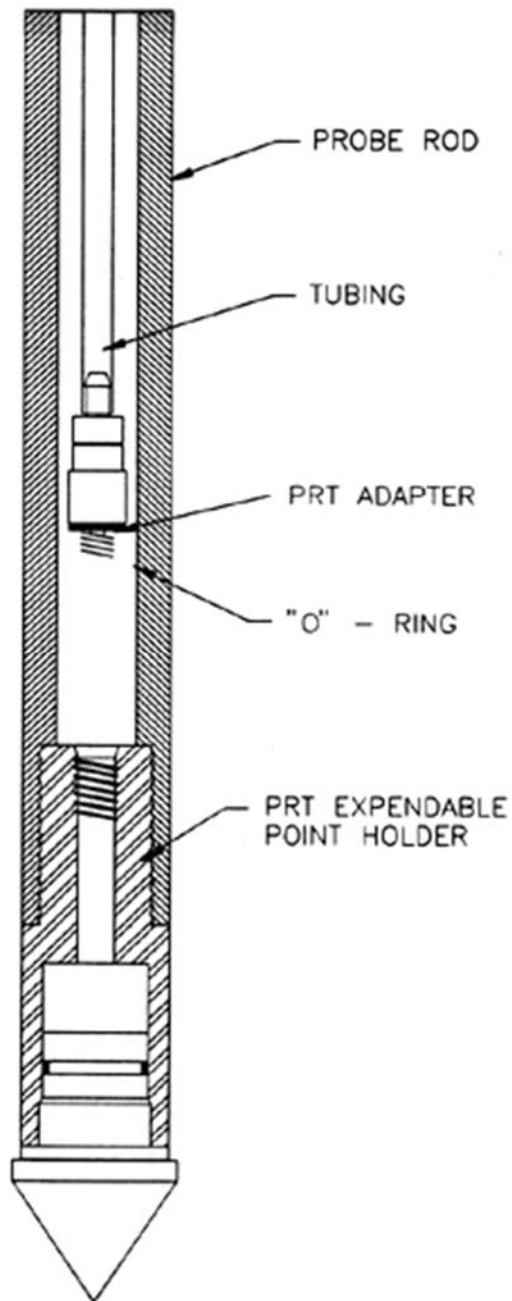


Figure 3
PRT Soil Gas Sampling System



Geoprobe® Sampling

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Figure 4
Groundwater Sampling

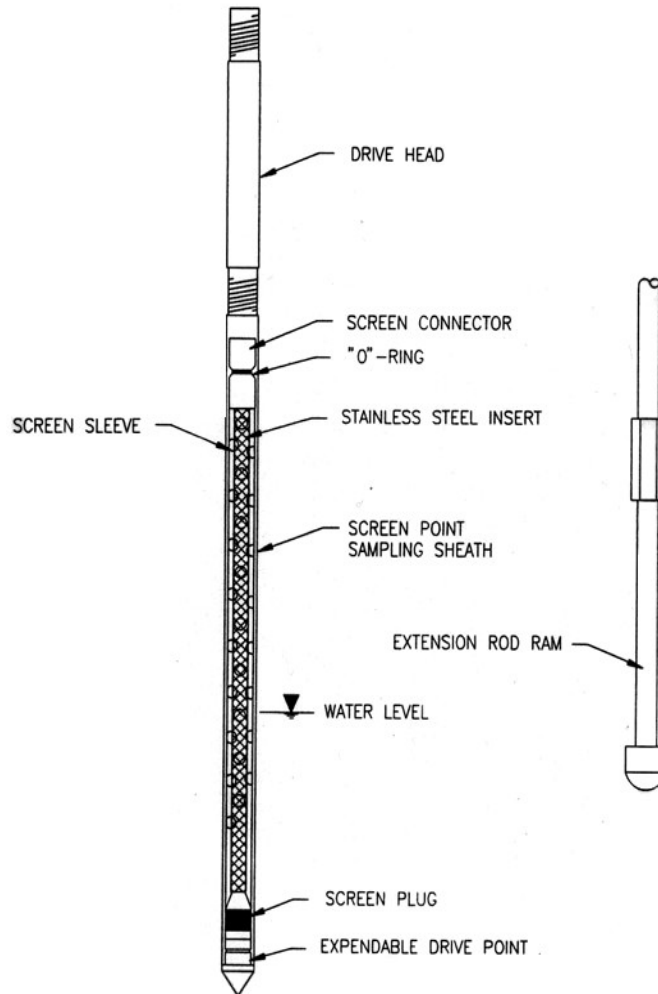
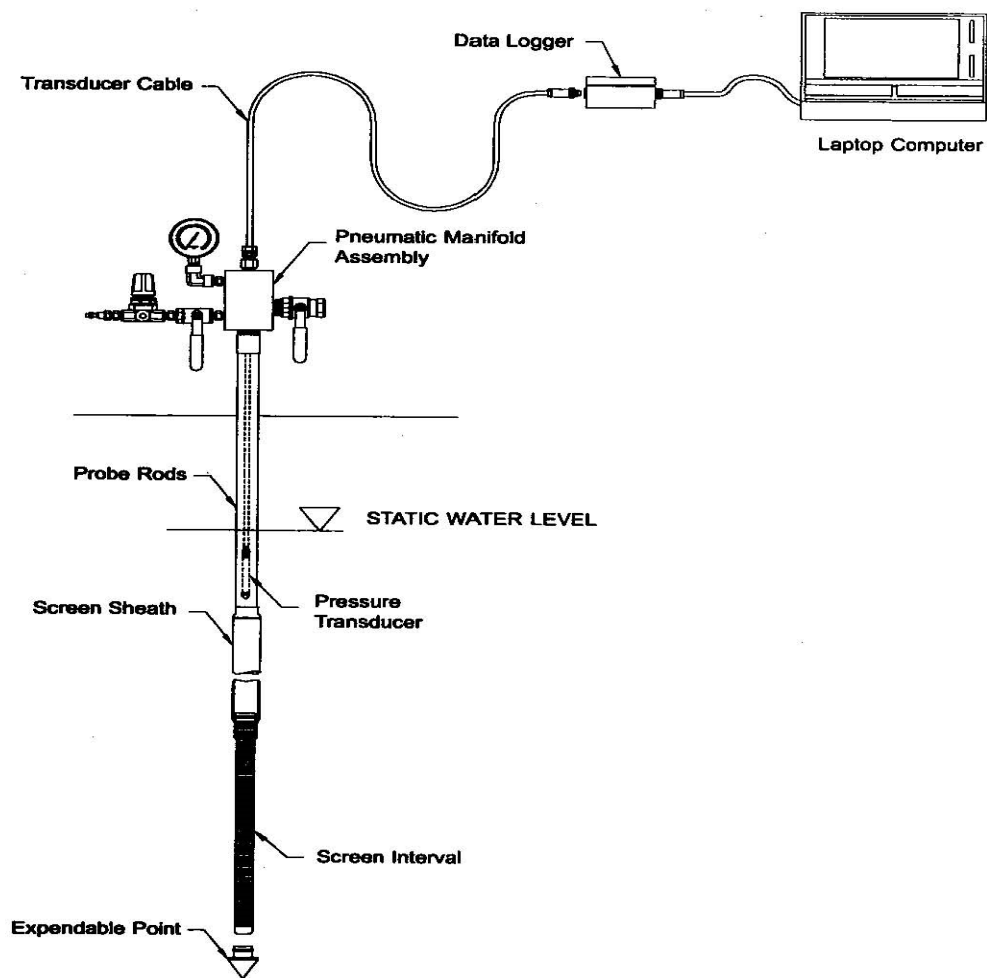


Figure 5
Pneumatic Slug Testing with an SP15/16 Groundwater Sampler



The


Topographic Survey

SOP 3-2

Revision: 8

Date: February 2015

Prepared:



Signature

Technical Review:

Todd Bragdon

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to provide guidance for a site topographic survey. The survey will produce a base map of the area under study, showing topographic and site-specific features. Also, the base map will incorporate site-specific grid system coordinates, if appropriate, to show sample and exploration location, monitoring wells, test pits, and any other features required by the scope of work.

2.0 Background

A site-specific grid system may be established at the area under study to coordinate the collection of samples. The topographic survey will establish the coordinates for the grid and facilitate the transposition of the grid and sample locations from the field to the topographic base map. At areas where a grid system is not used, sample and exploration locations will be marked by the field team using appropriate markers such as stakes, nails, flagging, or paint. The base map will also locate site-specific planimetric details such as significant manmade and geographic features via the survey. In developing the topographic survey scope of work (SOW), considerations for the initial base map development should also include future project needs such as engineering design.

The scale for the base maps will vary based on the size of the area under study, but a suitable scale will be selected that clearly shows map features and sample locations. The base maps will be at a scale appropriate for the intended use. Areas with significant detail requirements will be shown in scale that ranges from 1 inch equals 10 feet to 1 inch equals 40 feet. Areas with less detail requirements will be shown in smaller scale such as 1 inch equals 100 feet or 200 feet. Topography will be shown with 1- or 2-foot contour intervals. However, the contour interval shall clearly identify the variation in topography to the degree necessary for the work to be performed. For example, gently sloping areas may require a smaller contour interval (i.e., 1 foot between contour lines) to reveal more subtle topographic variations. Similarly, steeply sloping areas may require larger contour intervals to legibly depict the topography. Index contours shall be indicated at elevations that are multiples of five times the contour interval.

If appropriate, aerial photographs (i.e., orthorectified imagery) may be used to assist in the development of the topographic base maps. Existing or new photographs can be used for this purpose. In areas with deciduous trees, new photographs shall be taken during late fall or winter when the leaves are off the trees and better ground surface image can be achieved. The scale of the aerial photographs shall provide sufficient detail for developing the topographic base map.

3.0 General Responsibilities

Project Manager - The project manager is responsible for ensuring that the topographic survey is completed in accordance with the project requirements.

Field Team Leader - The field team leader is responsible for developing the survey scope of work and ensuring that the topographic survey is coordinated properly with the grid system (if used) and the sampling points, so that the base map produced is a true representation of the field locations.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-specific/project-specific quality assurance plan.

4.0 Required Equipment

The required equipment for a topographic survey shall be provided by the selected surveyor. All equipment proposed by the surveyor shall be submitted to CDM Smith for approval before initiating the topographic survey work.

The selected surveyor must be licensed professional surveyor (PLS) in the state in which the survey is conducted.

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For topographic surveys conducted at hazardous waste sites, all surveyor personnel who work onsite will be 40-hour health and safety trained per OSHA requirements for hazardous waste sites (29 CFR 1910.120), unless approved differently by the corporate health and safety manager.

All final drawings and maps must be signed and sealed by the licensed professional land surveyor.

5.0 Procedures

1. A site visit may be conducted before submitting the bid proposal. A kickoff meeting shall be held between the selected surveyor and CDM Smith's project manager to discuss the specific requirements of the scope of work.
2. The surveyor shall be responsible for executing the work, including deed search if required to support development of a legal description of the site or to establish property ownership boundaries.
3. The surveyor shall develop and implement a site-specific health and safety plan according to the requirements specified in the subcontract between CDM Smith and the surveyor.
4. To the extent practical, the work shall be performed in the presence of an authorized representative(s) of CDM Smith. CDM Smith will interpret and clarify the specifications and will answer all questions in connection therewith.
5. The CDM Smith field team leader will be responsible for ensuring that appropriate calibration procedures are performed and documented by the surveyor. Calibration procedures shall be consistent with the data quality objectives for the survey and with the equipment manufacturers' requirements.
6. The surveyor shall establish at least one primary horizontal control monument and one vertical benchmark, as established by the United States Coastal and Geodetic Survey (USC&GS) or equivalent authority. Additional monuments may be established by the surveyor.
7. Local benchmarks will be established at least every 500 feet or closer, if warranted by site conditions, to tie the basic control points together. Where required, established horizontal and vertical data, such as state planar coordinate systems and the national geodetic vertical datum of NAVD 88 or subsequent corrections and/or revisions, shall be used to tie the survey data to the national network.
8. Temporary monuments will be set as necessary to perform the surveying. They may be wood, metal, or otherwise marked on facilities such as sidewalks, paved streets, curbs, etc. All monuments shall be described in the field notes and marked on site maps for future reference.
9. If appropriate, the surveyor shall be encouraged to use technologies such as Global Positioning System (GPS) that will meet the accuracy requirements but that may be more flexible and efficient than traditional techniques. All geodetic control work shall conform to either the Standards and Specifications for Geodetic Control networks, Federal Geodetic Control Subcommittee or NAVSTAR Global Positioning System Surveying, U. S. Army Corps of Engineers, for third order Class II control surveys. Short traverses, less than 1 mile, may use generally accepted fourth order techniques (including vertical angles for elevations) that will provide the spatial accuracy required. Angles shall be doubled and redoubled if the mean of the doubled angle differs from the first angle by more than 10 seconds. Length measurements shall be made with a calibrated tape corrected for temperature and tension or with Electronic Distance Measuring (EDM) equipment corrected for variation of the index of refraction.
10. The CDM Smith field team leader will review the draft map to ensure that all sampling and exploration locations, grid coordinates, and other appropriate features are located by the surveyor. The surveyor will record all field survey information in a field logbook; a copy of the logbook shall be provided to CDM Smith with the submittal of the topographic map.

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11. A working drawing of the base map will be field checked and corrected by the surveyor as necessary. The completed topographic base map shall be plotted on Mylar® or other suitable drafting film, as directed by the CDM Smith project manager. All survey and topographical data will be in digital format, compatible with the latest version of AutoCAD, ArcView/ArcInfo, DXF, or geographic information system (GIS) export format may also be acceptable. The specific format of the data to be provided to CDM Smith will be specified in the SOW. It is recommended that a review of CDM Smith client requirements be completed to determine the appropriate data format. Sufficient documentation of the digital information shall be provided to explain the data. For clarity, the surveyor will prepare the base map with groups of features on separate layers in the AutoCAD files. The CDM Smith project manager shall designate which features will be placed on the separate layers. Tick marks indicating the latitude and longitude in the state that the work is performed shall be provided on the base map. The project manager will be responsible for ensuring that the topographic base map and digital information is completed according to CDM Smith's drafting standards for the project; it is recommended that CDM Smith's drafting standards be included in the SOW to ensure clear communication of project requirements.
12. In the event that aerial photographs are used, the surveyor shall field edit and statistically test the aerial topographic mapping of the site base map for conformance with the horizontal and vertical components of the National Map Accuracy Standards. The surveyor shall run random baselines throughout the site (minimum of four) to verify that less than 10 percent of horizontal and/or vertical locations exceed the values determined in the National Map Accuracy Standards. If more than 10 percent of the locations exceed the values in the National Map Accuracy Standards, then the surveyor will notify CDM Smith. The project manager will be responsible for ensuring that the orthorectified aerial photographs files are transferred electronically to CDM Smith along with other required deliverables in the SOW.
13. Stereo map compilation by stereo photogrammetric methods will be accomplished through the use of approved stereophotogrammetric instruments using professionally recognized plotting ratios for each type of instrument. Fully trained and experienced photogrammetrists will be employed to complete stereomaps compilation.
14. For broad area high precision topographic mapping, digital elevation/terrain model (DTM) compilation using light detection and ranging (LiDAR) technologies is becoming more common. This method can be an efficient and effective tool for increasing engineering production at all levels. However, the error budget for a given LiDAR mapping system is dependent on the accuracy of its core subsystems (i.e., the laser rangefinder, the GPS position solution, and the inertial measurement unit [IMU]). System engineers need to balance each subsystem contribution against desired system performance (Shrestha et al. 2000). The project manager will be responsible for ensuring that the DTM files are transferred electronically to CDM Smith along with other required deliverables in the SOW. DTM files can be utilized by AutoCAD Civil 3D for future modeling of the site.
15. The surveyor shall establish and maintain a quality control program to ensure that the survey is performed within acceptable limits. At a minimum, the surveyor will:
 - Check all equipment, including compasses, transits, and levels, for accuracy and maintain records of such checks. The surveyor will make records of these checks available to CDM Smith on request.
 - Maintain and submit copies of all survey field notes.
 - Field notes for each surveying activity will be kept in bound books dedicated exclusively to this project. Each book will have a table of contents. Each page of field notes shall be numbered, dated, and show the initials of all crewmembers. Black waterproof ballpoint pens will be used. Erasing is not acceptable. All errors will be crossed out with a single line and the correct data entered adjacent to the error. The crossed out and corrected data will be initialed by the party marking field notes.
16. Permits:
 - The surveyor shall be responsible for obtaining any federal, state, and local permits that may be required and to perform and complete the ground surveys at the site.
 - The surveyor shall not perform any work until permits (if required) are obtained.
 - The surveyor shall provide separate copies of all permits to CDM Smith before performing any onsite activities.

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6.0 Restrictions/Limitations

The horizontal positions are to be surveyed within 1/10 of a foot, relative to the datum coordinate system. The vertical elevations of monitoring wells, piezometers, and staff gauges are to be surveyed within 1/100 of a foot (0.01 foot), relative to the local benchmarks. The vertical elevations of all other sampling points are to be surveyed within 1/10 of a foot, relative to the local benchmarks.

7.0 References

U. S. Department of Commerce, National Geodetic Survey (see <http://www.ngs.noaa.gov>).

Moffitt, F.H. and Bouchard, H. 1982. *SURVEYING* (10th ed.), Harper and Row, Publishers, New York.

Shrestha, R. L. et al. 2007_Version 1.2. *Airborne Laser Swath Mapping: Accuracy Assessment for Surveying and Mapping Applications*. University of Florida (see http://ncalm.berkeley.edu/reports/NCALM_WhitePaper_v1.2.pdf).


Lithologic Logging

SOP 3-5

Revision: 9

Date: February 2015

Approved:



Signature

Technical Review:

David Schroeder

1.0 Objective

This technical standard operating procedure (SOP) governs lithologic logging of core, cuttings, split-spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed. The purpose of this SOP is to present a set of descriptive protocols and standardized reporting formats to be used in making lithologic observations. It prescribes protocols for recording basic lithologic data including, but not limited to, lithologic names, texture, composition, color, sedimentary structures, bedding, lateral and vertical contacts, and secondary features such as fractures and bioturbation.

The goal of this SOP is to provide a set of instructions to produce uniform lithologic descriptions and to present a list of references to help in this task.

2.0 Background**2.1 Definitions**

The following list of definitions corresponds to the description sequences outlined in Section 5.2.1. They are provided to aid the geologist in what to look for when following the sequences. Example lithologic logs are given in Attachment A.

Name of Sediment or Rock - In naming unconsolidated sediments, the logger shall use field equipment and reference charts to help identify the grain-size distribution and shall name the material according to the procedure in Section 5.2.1. In naming sedimentary, igneous, and metamorphic rocks, the logger shall examine the specimen for mineralogy and use the appropriate classification chart in the attachments.

Texture - In examining unconsolidated sediments, the texture shall refer to the grain-size distribution, particle angularity, sorting, and packing. The logger shall provide estimates of the grain sizes present using Attachment B and C. When larger particles such as cobbles are present, determine the size of the particles and give a percentage estimate. The sediment particles shall be examined for angularity by comparing with Attachment B and the sorting shall be determined by percentage estimation. The logger shall note that the Unified Soil Classification System (USCS) uses the term grading to describe how the materials are sorted. (A poorly sorted unconsolidated material is well graded.) In examining igneous rocks, texture refers to whether the specimen is aphanitic, phaneritic, glassy, fragmental, porphyritic, or pegmatitic. Attachment D has more specific definitions of these terms. For metamorphic rocks, texture refers to whether the specimen has a foliated structure (slaty, phyllitic, schistose, or gneissic) or nonfoliated structure (granular).

Color - Color may be determined using the appropriate Munsell color chart (soil or rock) and listing the Munsell number that corresponds to the color. If an unconsolidated material is mottled in color, the ranges in color shall be described. When describing core samples with several individual colors such as in phaneritic textures, individual color names shall be listed, and an overall best color name shall be given.

Sedimentary Structures - This term refers primarily to unconsolidated sediments and sedimentary rocks. There are several different sedimentary structures, and the logger is referred to Compton's *Manual of Field Geology* (1962) book for more details. Among the more common structures are bedding, cross-bedding, laminations, and burrows. These structures shall only be included in the description if found in the samples.

Degree of Consolidation - The degree of consolidation is applicable to sedimentary rocks and unconsolidated sediments and refers to how well the material has been indurated. Unconsolidated sediments may be compacted somewhat and shall be described as loose, moderately compacted, or strongly compacted. In some cases they may be slightly cemented by caliche and shall be described as slightly cemented, moderately cemented, or strongly cemented. Sedimentary rocks are typically indurated but may vary in the degree of cementation. These materials shall be described as friable, moderately friable, or well indurated. When describing the cementing material, a test for reaction to hydrochloric acid (HCl) shall be done and results recorded under the description. If the logger believes he/she can identify the cementing material, then it shall be included in the description.

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Moisture Content - Moisture content refers to the amount of water within the sediment or the matrix. Typically sedimentary rocks and unconsolidated sediments may have water within and shall be described as dry, moist, wet (not flowing), or saturated (flowing water). Igneous and metamorphic rocks may have water within fractures and cavities. The presence of water and pertinent observations that may help in site evaluation in these rocks shall be noted.

Presence of Fractures, Cavities, and Secondary Mineralization - The rock that may be encountered during drilling may have fractures or joints present within them. Should fractures be observed, they shall be noted and a description as to the density of fractures shall be given. Cavities or vugs may be present, and the density of voids, as well as size estimation, shall be given. If fractures or cavities contain evidence of secondary minerals such as zeolites, clays, or iron oxides, then a description of the mineral fill shall be added.

Evidence of Contamination - The logger shall examine the core and note any obvious signs of contamination such as streaking, free product, odor, or discoloration. These observations shall be noted in the field book as shall any readings from the photoionization or flame ionization detector (PID/FID). PID/FID hits shall be recorded on the Lithologic Log Form also.

Description of Contacts - The logger shall note any significant change in lithology. These changes may be gradational contacts within sediments or may be sharp contacts such as sediments over rocks. The contacts shall be noted as to whether they are erosional, gradational, or sharp, and the depth below the surface shall be noted.

Composition - The composition of the rock refers to the mineralogy of the material encountered. For sedimentary rocks, it is important to note the matrix composition and use Attachment E in naming. In igneous and metamorphic rocks, the minerals that make up the rock shall be stated and an estimation of their percentage shall be noted. The classification charts listed in Attachments D and F provide a description of common compositions.

2.2 Associated Procedures

- SOP 4-1, *Field Logbook Content and Control*

2.3 Discussion

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. The installation of these devices requires that a trained geologist, or other earth scientist under a geologist's supervision, provide lithologic descriptions as they encounter subsurface material during auguring or drilling. In evaluating these lithologic descriptions from different boreholes, monitoring wells, or piezometers, it is sometimes possible to correlate similar units. To help in this task, it is important to provide uniform and consistent descriptions.

In describing lithologies, it is helpful to have a set of references covering items such as the classification of igneous, metamorphic, and sedimentary rocks; grain-size percentage estimation; particle shape; grain-size charts; and lithologic symbols. To make lithologic descriptions produced by CDM Smith staff as uniform and consistent as possible, this SOP provides a list of references to be used in the field. This SOP also provides a sequence for recording information on a standardized log form to make descriptions as uniform and consistent as possible.

3.0 General Responsibilities

Geologist - The field person performing lithologic logging is responsible for making a consistent and uniform log and for turning in field forms and logbooks to the field team leader (FTL).

Field Team Leader (FTL) - The FTL is responsible for maintaining logbooks and forms and for approving techniques of lithologic logging not specifically described in this SOP.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/project specific quality assurance plan.

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4.0 Required Equipment

The description of subsurface lithologies requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used by the lithologic logger but does not include equipment such as drill rigs, PID/FID, sampling equipment, and personal protection equipment. The following is a general list of equipment that may be used:

- Field logbook and Lithologic Log Form
- Clipboard
- Dilute (10 percent) HCl
- Plastic sheeting
- PVC sampling trays
- Waterproof pens
- No. 2 sieve
- 10x magnifying hand lens
- Reference field charts
- Engineers tape measure or folding stick

5.0 Procedures**5.1 Office**

- Obtain field logbook and Lithologic Log Forms
- Coordinate schedules/actions with FTL
- Obtain necessary field equipment (i.e., hand lens, 10 percent HCl)
- Obtain CDM Smith reference field charts
- Review field support documents (i.e., sampling plan, health and safety plan)
- Review applicable geologic references such as U.S. Department of Agriculture (USDA) Soil Conservation Survey Soil Surveys and/or geologic maps

5.1.1 Documentation

Individuals performing lithologic logging will record their observations in a commercially available, bound field logbook (e.g., Lietz books) and/or on individual Lithologic Log Forms. Lithologic loggers will follow the general procedures for keeping a field logbook (SOP 4-1). When using a bound field logbook, record the same data required on the Lithologic Log Form. Data from the field logbook must be transcribed to the Lithologic Log Form if filling in the form in the field is not feasible. However, the data must be the same as that recorded in the field logbook. Editing of field logbook data is not allowed. In addition, if data are transcribed to the Lithologic Log Form, it shall be done within 1 day of the original data recording. All blanks in the Lithologic Log Form must be filled out. If an item is not applicable, an "NA" shall be entered. Note that the Lithologic Log may be modified based on the type of drilling (i.e., changing the blow count column to rock quality designation (RQD) for rock coring).

The Lithologic Log Form shall be filled out according to the following instructions:

The front page of the form contains general information:

- The project name, location, and description
- Borehole number
- Date that the drilling activity was started and completed
- Name of the person logging the well shall be recorded along with the total depth drilled
- Borehole diameter(s) and drilling methods shall be recorded
- Name and company of the driller and the type of drill rig and bits used

A map showing the drilling location may be attached.

The continuation page(s) shall be completed according to the instructions provided within this section and according to the sequence provided in Section 5.2.1. The depth column refers to the depth below ground surface and shall be provided in feet. The tick marks can be arbitrarily set to any depth interval depending on the scale needed except where client requirements dictate the spacing. The lithology column shall contain a schematic representation of the subsurface according to the symbols found in Attachment G. Use a single X to mark the area where no core was recovered, and notes shall be recorded as to why the section was not recovered. The X shall

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be marked from the top to the bottom of the section so that the entire interval is marked. If the geologist can interpret the probable lithology of the missing section with reasonable confidence, they may fill in the symbols behind the X. Sharp or abrupt contacts between lithologies will be indicated by a solid horizontal line. Gradational changes in lithologic composition will be shown by a gradual change of lithologic symbol in the appropriate zone. PID/FID hits shall be recorded within the PID/FID column at the appropriate depth, if applicable. Blow counts specifically refer to the number of hammer blows it takes to drive a split-spoon into the ground. Usually this is recorded as the number of blows per 6 inches but may vary. The recording of blow counts provides a relative feel for the cohesiveness of the formation. The individual recording lithologic logs shall ask the FTL whether it is required information. The description column is the most important part of the Lithologic Log Form and is where the lithology is described. In completing this section, use the applicable reference charts and complete according to the sequence in Section 5.2.1. The sample interval column is reserved for noting any samples taken and processed for the laboratory. The sample number shall be filled in at the appropriate depth. The last column refers to the percent core recovery. The individual performing lithologic logging shall determine the amount recovered and write the percentage at the appropriate depth.

In addition to the information on the lithologic form, the logger shall record the appropriate information into the logbook when there is a rig shutdown, rig problems, failures to recover cores, or other issues.

5.2 General Guidelines for Using and Supplementing Lithologic Descriptive Protocols

This SOP is intended to serve as a guide for recording basic lithologic information with emphasis on those sediment or rock properties that affect groundwater flow and contaminant transport. The fields of specialization of geologists using this SOP will vary. If the user has expertise in a particular field of petrology or soil science that allows for descriptions of certain geologic sections beyond the basic level required by this SOP, they may expand their descriptions. This shall be done only with approval of the FTL. The descriptive protocol presented here must be followed in making basic observations. Any further descriptions must follow a protocol that is published and generally recognized by the geologic community as a standard reference.

General lithologic description will not include collecting detailed information such as can be obtained from sieve analysis or petrographic analysis. This SOP is a guide for recording visual observations of samples in the field aided by a 10x hand lens and the other simple tools. Field descriptions shall be supplemented by petrographic analysis and sieve analysis when the FTL needs data on numerical grain-size distributions, secondary porosity development, or other data that can be collected by these methods.

Description detail will also be dependent on the drilling and sampling methods used. Descriptions of drill cuttings will generally be very basic verses detailed descriptions of soil split-spoon or rock core samples.

This SOP includes protocols for describing igneous, metamorphic, bedrock, sedimentary rocks, and unconsolidated materials. Common abbreviations used for lithologic logging purposes are given in Attachment H. This SOP includes charts to be used for classification and naming of rocks, sediments, and soils and descriptions of texture, sedimentary structures, and percentage composition of grains. There is also a chart of lithologic symbols to be used and a list of abbreviations. For charts covering other observations or field procedures not specified by this SOP, the user is referred to the following for more information:

- *Compton's Manual of Field Geology and American Geological Society (AGI) Data Sheets for Geology in the Field, Laboratory, and Office* contain other reference charts applicable to descriptions. The source of the chart used must be recorded on the Lithologic Log Form or in the field logbook.
- The Munsell soil color chart may be used for descriptions of color.
- The *Dictionary of Geological Terms* (AGI) is to be used for definitions of geological terms.

Some observations will be common to all rock and soil descriptions. All descriptions shall include as appropriate: name of sediment or rock, color, sedimentary structures, texture, moisture content, composition, fabric, significant inclusions, and degree of consolidation or induration. The description of each category shall be separated by a semicolon. Each section that discusses descriptions of a particular lithology provides a sequence for recording observations. Follow these sequences for all descriptions. All interpretive comments shall be segregated from lithologic descriptions by recording them in the remarks column.

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Secondary features affecting porosity and permeability such as fractures (joints or faults), cavities, and/or bioturbation shall be described if observed. Exact measurement of apparent bed thicknesses shall be made when logging core and shall supplement terminology such as “thin” or “thick.” Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible.

In some cases individuals logging may wish to describe materials such as unconsolidated sediments and soils according to different systems such as the USCS or USDA Soil Taxonomy System. These descriptions can provide additional information from what is required by this SOP. If an individual is competent in using other description methods, then they shall do so with permission from the FTL.

It is often more practical to use abbreviations for often repeated terminology when recording lithologic descriptions. For the terms given in this SOP, its attachments, or the associated charts to be used for description in the field, use only the designated abbreviations. Other abbreviations are allowed; however, the abbreviation and its meaning shall be recorded on the lithologic log the first time it is used and shall be recorded at least once for every well or boring log. Loggers are cautioned to limit the use of abbreviations to avoid producing a lithologic log that is excessively cryptic.

5.2.1 Protocols for Lithologic Description of Discrete Soil or Rock Cores

This section describes the protocols for completing a lithologic description based on discrete soil or rock core samples. The logger shall use the appropriate portion of this section when describing cores. In recording descriptions of sedimentary sections from a whole core, it is possible to reduce the amount of description being written by at least two strategies. One is to look at as long of a section of core as possible, looking for the “big” picture. For instance, in a 20-foot-thick zone, the dominant lithology may be siltstone that is interrupted by several thin beds of another lithology such as gravel. This section description can be simplified by writing: 35-55 below ground surface (bgs) = siltstone (with other descriptors) except as noted; 37.5-38.5 gravel zone (with descriptors); 40-42 pebble zone (with descriptors); etc. This also aids in “seeing” the thickest unit designations possible for use in modeling. Another acceptable way to describe the same interval would be: 35-37.5 siltstone; 37.5-38.5 gravel zone (with descriptors); 38-40 same as 35-37.5; 40-42 pebble zone (with descriptors); etc.

Description of Unconsolidated Material

Unconsolidated material comprises a significant portion of the sections of interest at CDM Smith sites. The shallow subsurface is very important to the hydrologic investigation, as this is the portion of the geologic section where infiltration first occurs. Much of the contamination at sites being investigated is surface contamination and therefore lies on, or within, the upper portion of the surficial material.

For the purpose of this SOP, soil refers to the upper biochemically weathered portion of the regolith and not the entire regolith itself. Soils are to be described as unconsolidated material and shall use the same description format. The scientist shall use the USCS classification if consistent with project objectives (Attachment K). More detailed soil descriptions shall only be made in addition to descriptions outlined below.

Descriptions of unconsolidated sediments shall follow the following sequence:

- Name of sediment (sand, silt, clay, etc.)
- Texture
- Composition of larger-grained sediments
- Color
- Structure
- Degree of consolidation and cementation
- Moisture content
- Evidence of bioturbation
- Description of contacts

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In naming unconsolidated material (refer to Attachment I - Naming of Unconsolidated Materials), the particle size with the highest percentage is the root name. When additional grains are present in excess of 15 percent, the root name is modified by adding a term in front of the root name. For instance, if a material is 80 percent sand and 20 percent gravel, then it is gravelly sand. If the subordinate grains comprise less than 15 percent but greater than 5 percent, the name is written:

_____ (dominant grain) with _____ (subordinate grain). For example, a sediment with 90 percent sand and 10 percent silt would be named a sand with silt. If a sediment contains greater than 15 percent of four particle sizes, then the name is comprised of the dominant grain size as the root name and modifiers as added before. For example, if a material is 60 percent sand, 20 percent silt, and 20 percent clay the name would be a silty clayey sand. If a material is 70 percent sand, 20 percent silt, and 10 percent clay, it would be a silty sand with clay. When large cobbles or boulders are present, their percentage shall be estimated and their mineralogy recorded. Use AGI Data Sheet 29.1 (Attachment B) for grain terms. Refer to Attachment J for an example sorting chart.

Description of Bedrock Material

Descriptions of rock core can vary in detail depending on the experience of the geologist and the scope of the project. However, features that shall be noted while logging rock core include depth of major fractures, mineralization in fractures and cavities, degree of weathering, hardness, and RQD. The RQD is a ratio of the total length of intact rock 4 inches in length or longer to the length of the core run. The RQD provides a numeric indication of the degree of fracturing and weathering, and thereby, and indication of conductive zones and preferential contaminant migration pathways.

Description of Sedimentary Rocks

Sedimentary rocks consist of lithified detrital sediments such as sand and clay, chemically precipitated sediments such as limestone and gypsum, and biogenic material such as coal and coquina. The classification scheme for naming these rocks is found in Attachment E - Classification of Sedimentary Rocks.

Descriptions for sedimentary rocks shall be given in the lithologic log in the following sequence:

- Name of rock
- Texture
- Color
- Bedding
- Sedimentary structures
- Degree of composition
- Presence of fractures or vugs
- Bioturbation
- Description of contacts

Description of Igneous and Metamorphic Rocks

Igneous and metamorphic rocks are not as commonly observed at work sites, but they may be found interspersed in the sedimentary section as ash layers and as bedrock. Where they form bedrock, the development of fractures and vugs is important to their hydrologic properties. If the logger is unsure of the name of the rock because of difficulty in determining mineralogy, the name shall be accompanied by a question mark. Attachments D and F provide a classification system for these materials.

Igneous and metamorphic rock descriptions shall follow the general format:

- Name of rock
- Texture
- Color
- Degree of induration for volcanics
- Composition
- Presence of fractures or vugs
- Presence of secondary mineralization
- Foliation

5.2.2 Protocols for Lithologic Description from Drill Cuttings

The majority of boreholes drilled in bedrock are drilled without sampling or coring. This section describes the protocols that may be used for completing lithologic logs when discrete soil samples or rock cores are not collected. Lithologic logging of boreholes drilled without sampling generally requires a higher level of experience from the geologist as interpretations need to be made based on a number of factors that are usually not taken into account when logging from discrete samples. Certain details recorded on lithologic logs based on discrete sampling will not be seen (such as sedimentary structures) and therefore cannot be recorded from drill cuttings. Below are general guidelines that shall be used while filling out boring logs based on drill cuttings:

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Auger Drilling

The following are general guidelines that can be used to describe cuttings from auger drilling:

- Collect cuttings for descriptions at least every 5 feet or if a change in the cuttings is noticed.
- Keep in mind travel time for cuttings to reach the surface when estimating the depth from which the cuttings originated.
- Pay attention to the reaction of the drill rig as different lithologies are encountered such as chattering versus smooth drilling, rapid easy auger advancement versus slow hard drilling, and auger refusal.
- Watch for the occurrence of water.

Bedrock Rotary Drilling (including air hammer, air rotary, and mud rotary)

The following are general guidelines that shall be used during rotary drilling:

- Use a strainer to collect cuttings at intervals of at least 10 feet or changes in lithology.
- Wash the cuttings in the strainer with potable water and examine for lithology.
- Note size of rock chips.
- Note changes in drill rig responses such as increasing or slowing drilling rate, sudden drop of the drill stem, increase in chatter and record in the remarks column of the lithologic log. These are usually good indicators of changes in lithology and/or fractures.
- If drilling with air, look for changes in color and reduction or disappearance of dust as an indicator of a lithology change and/or presence of water.
- If drilling with mud/fluid rotary, watch for gain or loss of water as an indicator of conductive zones.
- Record drilling rates as feet/minute, or as start and end times of each drill rod, in the remarks column of the boring log.

6.0 Restrictions/Limitations

Only geologists, or similarly qualified persons trained in lithologic description, are qualified to perform the duties described in this SOP. The FTL for a project will have the authority to decide whether or not an individual is qualified.

7.0 References

American Geological Society. 1989. *American Geological Society Data Sheets for Geology in the Field*, Laboratory, and Office, 3rd Ed.

Compton, R.R. 1962. *Manual of Field Geology*, John Wiley & Sons Inc., New York, New York.

Neuendorf, K.K.E, et. Al. 2005. *Glossary of Geology, Fifth Edition*, American Geological Institute.

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_____. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites, EM 1110-1-4000*, Chapter 4. November 1.

U. S. Department of Agriculture Soil Conservation Service. 1999. *Soil Taxonomy, A Basic System of Soil Classification for Making and Interpreting Soil Surveys*. Second Addition.

Woodward, L.A. 1988. *Laboratory Manual Physical Geology*, University of New Mexico Printing. Albuquerque, New Mexico.

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8.0 Attachments

Note: These Attachments are for informational purposes. Other equivalent charts such as USCS or logs may be used.

Attachment A - Lithologic Logs

Attachment B - Grain-Size Scale; Graph determining size of sedimentary particles, particle degree of roundness charts

Attachment C - Comparison Chart for Estimating Percentage Composition

Attachment D - Classification of Igneous Rocks

Attachment E - Classification of Sedimentary Rocks

Attachment F - Classification of Metamorphic Rocks

Attachment G - Lithologic Symbol Chart

Attachment H - Common Abbreviations for Lithologic Logging

Attachment I - Naming of Unconsolidated Materials

Attachment J - Sorting Chart

Attachment K - Example of Unified Soil Classification System (USCS)

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Attachment A**Lithologic Logs**

CORING LOG		Client		Boring Number	
Company Name CDM Smith		Drilling Subcontractor		Sheet 1 of Sheets	
Project		Location			
Name of Driller		Drill Rig(s)			
Sizes and Types of Drilling and Sampling Equipment		Northing	Easting	ORNL Grid	
		Surface Elevation			
		Date Started		Date Completed	
Overburden Thickness		Depth Groundwater Encountered			
Depth Drilled into Rock		Depth to Water and Elapsed Time After Drilling Completed			
Total Depth of Hole		Other Water Level Measurements (Specify)			
Drilling Method	Borehole Diameter(s)	Depth of Surface Casing			
Total Core Recovery	Total Number of Core Boxes	Signature of Geologist			
Location Map					
Project					Boring Number

Lithologic Logs (cont.)

CORING LOG								Boring Number:
Project:						Geologist:		Sheet of Sheets
Elev (ft)	Depth (ft) bgs	Description of Materials	USCS/Litho	Field Screening Results (ppm)	Core Run No.	RQD	Recovery (ft)	Remarks

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Attachment A

Lithologic Logs (cont.)

DRILLING LOG			Client		Boring Number	
Company Name CDM Smith			Drilling Subcontractor		Sheet 1 of Sheets	
Project			Location			
Name of Driller			Drill Rig(s)			
Sizes and Types of Drilling and Sampling Equipment			Northing	Easting	ORNL Grid	
			Surface Elevation			
			Date Started		Date Completed	
Overburden Thickness			Depth Groundwater Encountered			
Depth Drilled into Rock			Depth to Water and Elapsed Time After Drilling Completed			
Total Depth of Hole			Other Water Level Measurements (Specify)			
Drilling Method		Borehole Diameter(s)	Depth of Surface Casing		Signature of Geologist	
Location Map						
Project						Boring Number

Lithologic Logs (cont.)

DRILLING LOG							Boring Number:	
(continuation sheet)								
Project:				Geologist:			Sheet of Sheets	
Elev (ft)	Depth (ft) logs	Description of Materials	USCS Litho	Field Screening Results (ppm)	Sample No.	Blow Counts	Recovery (ft)	Remarks

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Attachment B

Grain-Size Scale; Graph determining size of particles,
particle degree of roundness charts

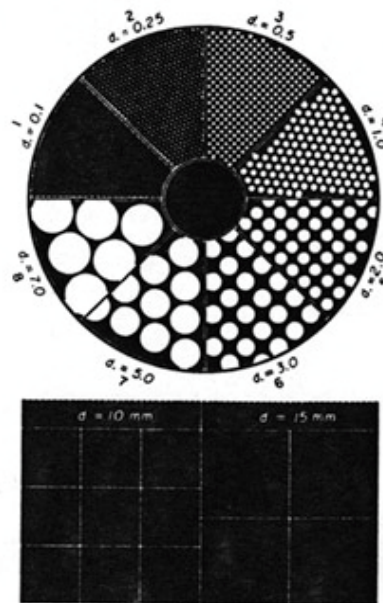
AGI DATA SHEET 28.1

Grain-size Scales
By Roy L. Ingram, University of North Carolina
GRAIN-SIZE SCALE USED BY AMERICAN GEOLOGISTS
Modified Wentworth Scale — after Lane, et al., 1947, Trans. American Geophysical Union, v. 28, p. 936-938

phi	GRADE LIMITS			U.S. Standard Sieve Series	GRADE NAME	
	mm	mm	inches			
-12	4096	-	-161.3	-	-	-
-11	2048	-	80.6	-	very large	-
-10	1024	-	40.3	-	large	Boulders
-9	512	-	20.2	-	medium	-
-8	256	-	10.1	-	small	-
-7	128	-	5.0	-	large	Cobbles
-6	64	-	2.52	63 mm	small	GRAVEL
-5	32	-	1.26	31.5 mm	very coarse	-
-4	16	-	0.63	16 mm	coarse	Pebbles
-3	8	-	0.32	8 mm	medium	-
-2	4	-	0.16	No. 5	fine	-
-1	2	-	0.08	No. 10	very fine	-
0	1	-	0.04	No. 18	very coarse	-
+1	1/2	0.500	-	No. 35	coarse	Sand SAND
+2	1/4	0.250	-	No. 60	medium	-
+3	1/8	0.125	-	No. 120	fine	-
+4	1/16	0.062	-	No. 230	very fine	-
+5	1/32	0.031	-	-	coarse	-
+6	1/64	0.016	-	-	medium	Silt
+7	1/128	0.008	-	-	fine	-
+8	1/256	0.004	-	-	very fine	MUD
+9	1/512	0.002	-	-	coarse	-
+10	1/1024	0.001	-	-	medium	Clay size
+11	1/2048	0.0005	-	-	fine	-
+12	1/4096	0.00025	-	-	very fine	-

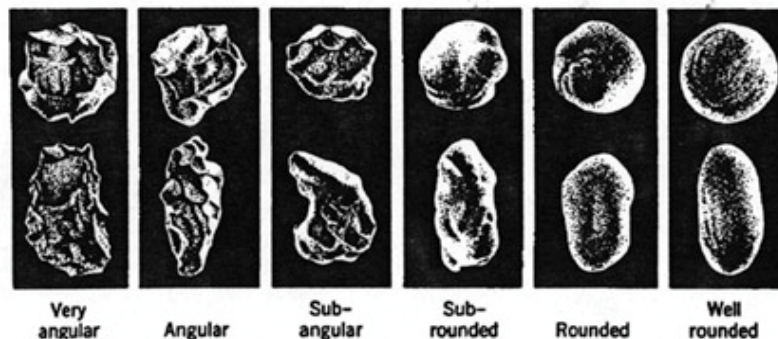
AGI-28-1-88

AGI DATA SHEET 28.2
LIGHT PARTICLES



References: (1) George V. Chilingar, 1956, Soviet classification of sedimentary particles and Vasil'evsky graph; AAPG Bull., v. 40, no. 7, p. 1714. (2) M.S. Shvetsov, 1946, Petrography of sedimentary rocks, 2nd ed., 367 p. Gostgeolizdat, Moscow-Leningrad.

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Lithologic Logging

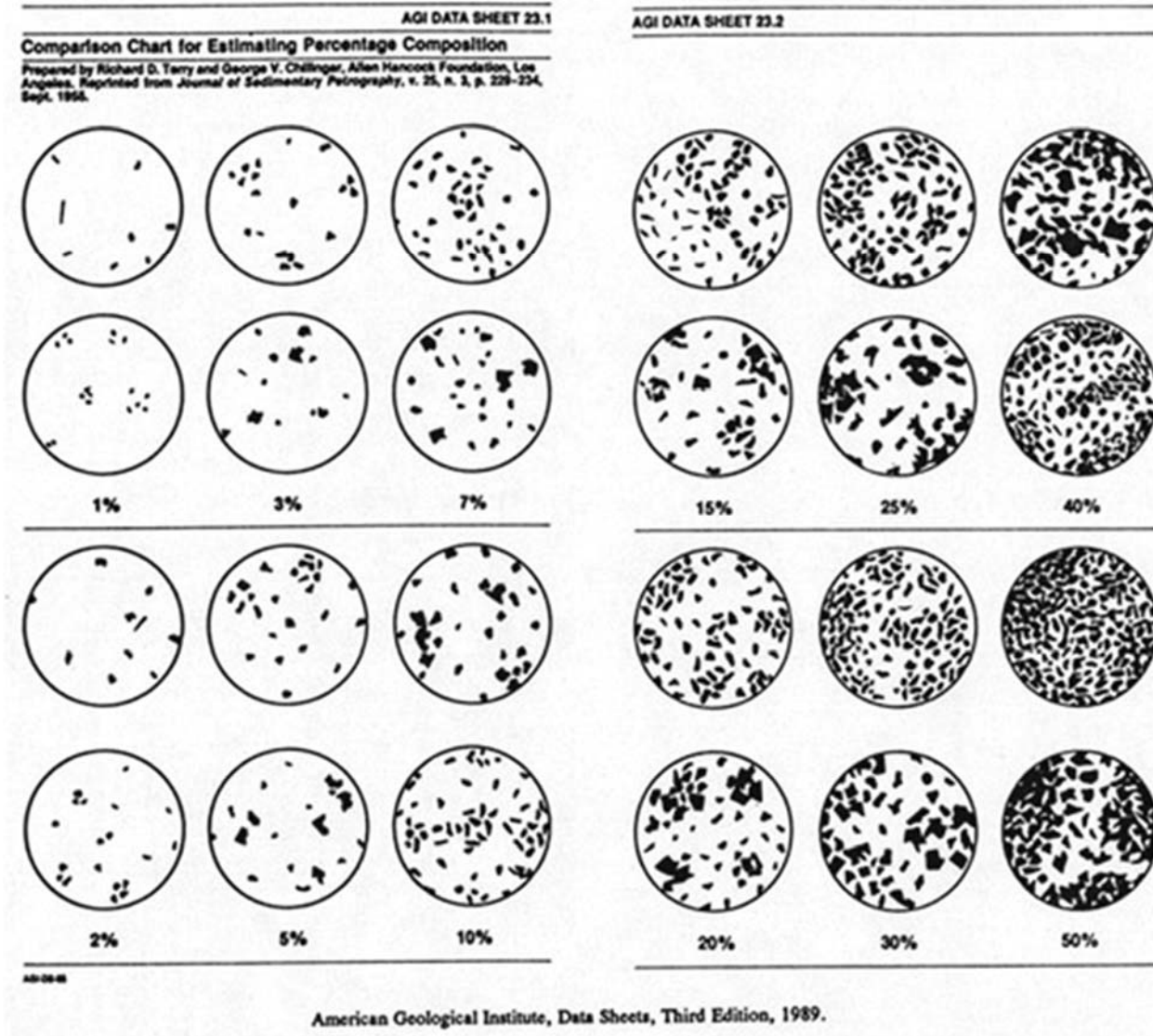
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Attachment C

Comparison Chart for Estimating Percentage Composition



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Attachment D

Classification of Igneous Rocks

Classification of Igneous Rocks					
Mineral Composition					
		Quartz >10% Abundant feldspar Mafic minerals minor	Quartz <10% Abundant feldspar Mafic minerals moderate	Feldspar abundant Mafic Minerals 40-70%; Quartz minor or absent	Mafic minerals >70%
Color Index		Light Color	Intermediate color	Dark	Dark
Chemistry		SiO ₂ 70%	SiO ₂ 60%	SiO ₂ 50%	SiO ₂ 40%
	Phaneritic (visible with naked eye)	Granite (Gr)	Diorite (Dr)	Gabbro (Gb)	Peridotite (Pr) (mostly olivine)
T E X T U R E	Aphanitic (microscopic)	Rhyolite (Ry) (quartz phenocrysts)	Andesite (An) (feldspar or mafic phenocrysts; no quartz)	Basalt (Ba)	Komatiite (Km) (very rare)
		Felsite (Fl) (no phenocrysts)			
	Glassy	Obsidian (ob) Pumice (Pu)		Rare	
	Glassy-Fragmental (Pyroclastic)	Tuff <4mm (Tf) Breccia >4mm (Br)		Rare	

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Attachment E

Classification of Sedimentary Rocks

Classification of Sedimentary Rocks				
Detrital	Detrital Classification	Principal Composition	Additional Identifying Characteristics	Name of Rock
	Rudaceous (clast diameter > 2 mm)	Gravel	Rounded Clasts	Conglomerate (Cg)
			Angular Clasts	Breccia (Br)
	Arenaceous (clast diameter between 0.0625 mm [1/16 mm] and 2 mm)	Sand	Mineral composition and detrital matrix content varies. Additional detrital matrix qualifiers (arenite or wacke) and mineral composition qualifiers (quartz, arkose, feldspathic, etc.) may be necessary.	Sandstone (Sa)
	Argillaceous (clast diameter <0.0625 mm)	Mud	Non-fissile along bedding planes, silt predominant over clay	Siltstone (Sl)
			Non-fissile along bedding planes, clay predominant over silt	Claystone
			Non-fissile along bedding planes, silt and clay fraction approximately equal or unknown	Mudstone (Ms)
			Fissile along bedding planes	Shale (Sh)
Chemical	Chemical Classification	Principal Composition	Additional Identifying Characteristics	Name of Rock
	Calcareous	Calcite (Calcium Carbonate)	Effervesces on contact with dilute HCl	Limestone (La)
		Dolomite (Calcium Magnesium Carbonate)	Pulverized sample effervesces on contact with dilute HCL	Dolomite (Dl), Dolostone
	Siliceous	Quartz (Silicon Dioxide)	Hard, dense, fractures conchoidally	Chert (Ch)
	Evaporites	Hydrated Calcium Sulfate	Earthy and crumbly	Gypsum (Gy)
		Calcium Sulfate	Usually exhibits indistinct stratification	Anhydrite
		Halite (Sodium Chloride)	Cubic cleavage	Rock Salt (Na)
Organic (Organogenetic or Biochemical)	Chemical Classification	Principal Composition	Additional Identifying Characteristics	Name of Rock
	Calcareous	Fossil shells and fragments	Loosely cemented fragmental limestone	Coquina (Cq)
		Foraminiferal shells	Soft, micritic limestone	Chalk (Chk)
		Calcite or aragonite	Derived from evaporation of spring water	Travertine (Tvr)
	Siliceous	Diatom shells (saltwater or freshwater organisms)	Light-colored, soft, friable, and porous siliceous deposit	Diatomite (Dm)
	Carbonaceous	Plant Remains	Degree of lithification varies-additional qualifiers such as peat, lignite, bituminous and anthracite may be necessary.	Coal (Cl)

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Attachment F

Classification of Metamorphic Rocks

Classification of Metamorphic Rocks			
Structure	Texture	Chief Minerals	Name
Non foliate	granular; breaks across grains	quartz	Quartzite (Qzt)
	granular; grains clearly visible	calcite	Marble (Mbl)
	granular; grains altered and indistinct	plagioclase, chlorite, epidote hornblende	Greenstone (Grs)
	very fine-grained	indistinguishable; mostly submicroscopic micas and clays	Hornfels (Hnf)
Foliate	slaty	submicroscopic mica, quartz	Slate (Slr)
	phyllitic	microscopic mica, quartz	Phyllite (Pyl)
	schistose	microscopic mica, quartz, amphibole	Blueschist
		chlorite, mica plagioclase	chlorite schist (CL-Sch)
		muscovite, quartz	Muscovite (Ms) Schist (Sch)
		garnet, muscovite	Garnet (G) Muscovite (Ms) Schist (Sch)
		hornblende, plagioclase	Amphibolite (Amp)
		staurolite, garnet, muscovite	Garnet (G) Staurolite (S) Muscovite (Ms) Schist (Sch)
		plagioclase, hornblende	Amphibolite (Amp) Gneiss (Gns)
	gneissose	feldspar, quartz	Granite (Gr) Gneiss (Gns)
		eye-shaped feldspar, mica	Augen (Au) Gneiss (Gns)

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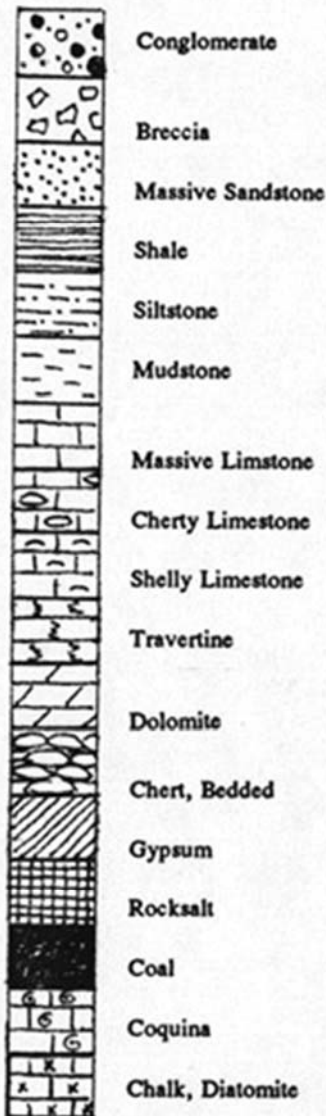
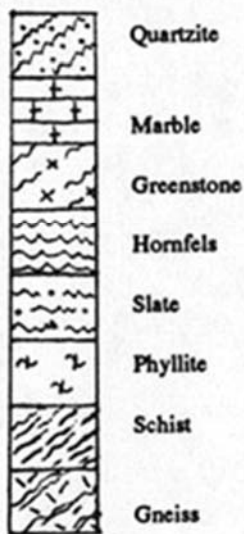
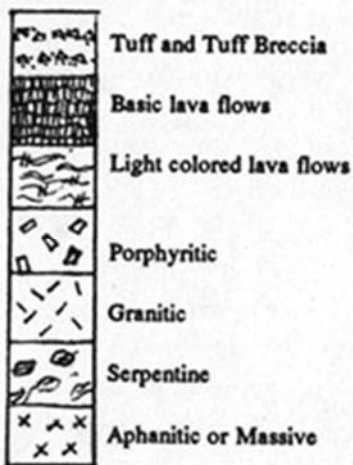
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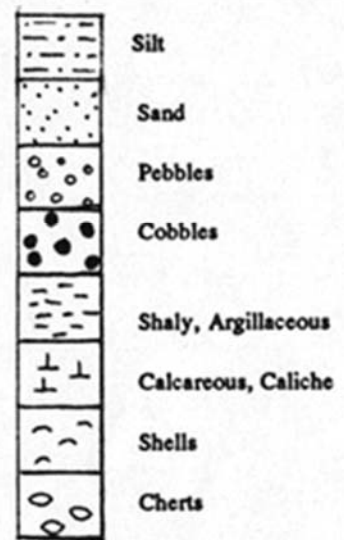
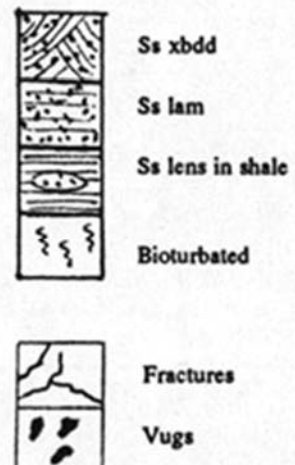
Date: February 2015

Attachment G

Lithologic Symbol Chart

Symbols for
Sedimentary RocksSymbols for
Metamorphic RocksSymbols for
Igneous Rocks

Symbols for Grains

Symbols for
Bedding

Compton, R.R., Manual of Field Geology, 1962.

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Attachment H**Common Abbreviations for Lithologic Logging**

Common Abbreviations		
Abundant – abnt	Diameter – dia	Laminated – lam
Amount – amt	Different – diff	Maximum – max
Approximate – approx	Disseminated – dissem	Pebble – pbl
Arenaceous – aren	Elevation – elev	Phenocryst – phen
Argillaceous – arg	Equivalent – equiv	Porphyritic – proph
Average – ave	foliated – fol	Probable – prob
Bedded – bdd	Formation frm	Quartz – qrz
Bedding – bdg	Fracture – frac	Regular – reg
Calcareous – calc	Fragmental – frag	Rocks – rx
Cemented – cmt	Granular – Gran	Rounded – rnd
Cobble – cbl	Gypsiferous – Gyp	Saturated – sat
Contact – ctc	Horizontal – hriz	Secondary – sec
Cross-bedded - xbdd	Igneous – ign	Siliceous – sil
Cross-bedding – xbdg	Inclusion – incl	Structure – struc
Cross-laminated – xlam	Interbedded – intbdd	Unconformity – uncnf
Crystal – xl	Irregular – irreg	Variegated – vrgt
Crystalline – xln	Joint – jnt	Vein – vn
Grain Size	Contacts	Sorting
grain – gn	gradational – grad	poor – pr
fine – f	erosional – er	moderate – mod
very fine – vf	abrupt – ab	well – well
medium – med		
coarse – crs	Fabric	
large – lg	grain supported – gs	
very large – vlg	matrix supported – ms	
small – sm	imbricate – im	

Adapted from, Compton, R.R., *Manual of Field Geology*, 1962.

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Attachment I

Naming of Unconsolidated Materials

Main Particle	Gravel	Sand	Silt	Clay
> 15 % gravel	Gravel	Gravelly Sand	Gravelly Silt	Gravelly Clay
> 15 % sand	Sandy Gravel	Sand	Sandy Silt	Sandy clay
> 15 % silt	Silty Gravel	Silty Sand	Silt	Silty Clay
> 15 % clay	Clayey Gravel	Clayey Sand	Clayey Silt	Clay
5-15 % gravel	Not Applicable	Sand with Gravel	Silt with Gravel	Clay with Gravel
5-15 % sand	Gravel with sand	Not applicable	Silt with Sand	Clay with sand
5-15 % silt	Gravel with silt	Sand with silt	Not applicable	Clay with silt
5-15 % clay	Gravel with clay	Sand with clay	Silt with clay	Not applicable
> 15% gravel plus 15% sand	Sandy Gravel	Gravelly Sand	Gravelly Sandy Silt	Gravelly Sandy Clay
> 15% gravel plus 15% silt	Silty Gravel	Gravelly Silty Sand	Gravelly Silt	Gravelly Silty Clay
> 15% gravel plus 15% clay	Clayey Gravel	Gravelly Clayey Sand	Gravelly Sandy Silt	Gravelly Clay
> 15% sand plus 15% silt	Silty Sand Gravel	Silty Sand	Sandy Silt	Sandy Silty Clay
> 15% sand plus 15% clay	Sandy Clayey Gravel	Clayey Sand	Sandy Clayey Silt	Sandy Clay
> 15% silt plus 15% clay	Silty Clayey Gravel	Silty Clayey Sand	Clayey Silt	Silty Clay
Note: Other combinations are possible when all particle sizes are present in greater than 15%. For example, a Silty Clayey Gravelly Sand. Other possible combinations exist such as a Gravelly Sand with silt.				

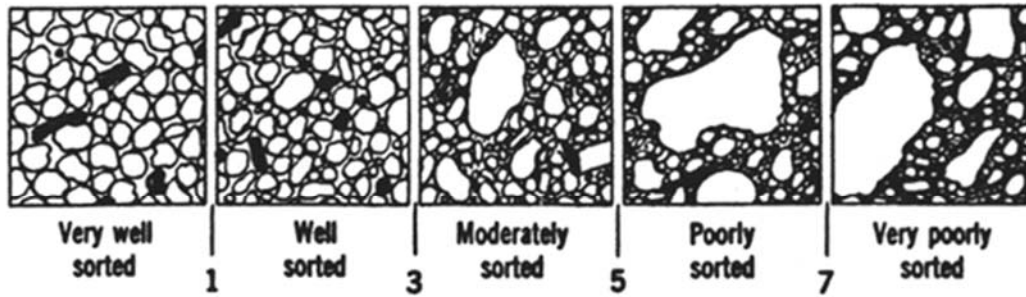
Compton, R.R., *Manual of Field Geology*, 1962.

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Attachment J

Sorting Chart



Compton, R.R., Manual of Field Geology, 1962.

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Attachment K

Example of Unified Soil Classification System (USCS)

Unified Soil Classification System (USCS)			
	MILLIMETERS	INCHES	SIEVE SIZES
BOULDERS	> 300	> 11.8	-
COBBLES	75 - 300	2.9 - 11.8	-
GRAVEL:			
COARSE	75 - 19	2.9 - .75	-
FINE	19 - 4.8	.75 - .19	3/4" - No. 4
SAND:			
COARSE	4.8 - 2.0	.19 - .08	No. 4 - No. 10 
MEDIUM	2.0 - .43	.08 - .02	No. 10 - No. 40 
FINE	.43 - .08	.02 - .003	No. 40 - No. 200 
FINES:			
SILTS	< .08	< .003	< No. 200 
CLAYS	< .08	< .003	< No. 200

Lithologic Logging

SOP 3-5

Revision: 9

Date: February 2015

Attachment K

Example of Unified Soil Classification System (USCS)
(Continued)

C L A Y

CLAY CONSISTENCY	THUMB PENETRATION	SPT, N BLOWS/ FT.	Undrained Shear Strength c (PSF)	Unconfined Compressive Strength q_u
			TORVANE	Pocket Penetrometer
VERY SOFT	Easily penetrated several inches by thumb. Exudes between thumb and finger's when squeezed in hand.	< 2	250	500
SOFT	Easily penetrated one inch by thumb. Molded by light finger pressure.	2 - 4	250 - 500	500 - 1000
MEDIUM STIFF	Can be penetrated over 1/4" by thumb with moderate effort. Molded by strong finger pressure.	4 - 8	500 - 1000	1000 - 2000
STIFF	Indented about 1/4" by thumb but penetrated only with great effort.	8 - 15	1000 - 2000	2000 - 4000
VERY STIFF	Readily indented by thumbnail.	15 - 30	2000 - 4000	4000 - 8000
HARD	Indented with difficulty by thumbnail.	> 30	> 4000	> 8000

S A N D

SOILTYPE	SPT, N Blows/ft.	Relative Density, %	FIELD TEST
VERY LOOSE SAND	4	0 - 15	Easily penetrated with 1/2" reinforcing rod pushed by hand.
LOOSE SAND	4 - 10	15 - 35	Easily penetrated with 1/2" reinforcing rod pushed by hand.
MEDIUM DENSE SAND	10 - 30	35 - 65	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
DENSE SAND	30 - 50	65 - 85	Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer.
VERY DENSE SAND	50	85 - 100	Penetrated only a few inches with 1/2" reinforcing rod driven with 5-lb hammer.

Lithologic Logging

SOP 3-5

Revision: 9

Date: February 2015

Attachment K

**Example of Unified Soil Classification System (USCS)
(Continued)**

Summary of USCS Field Identification Tests							
Coarse-Grained Soils More than half the material (by weight) is individual grains visible to the naked eye	Gravelly Soils More than half of coarse fraction is larger than 4.75 mm		Clean Gravels Will not leave a stain on a wet palm	Substantial amounts of all grain particle sizes			GW
				Predominantly one size or range of sizes with some intermediate sizes missing			GP
			Dirty Gravels Will leave a stain on a wet palm	Non-plastic fines (to identify, see ML below)			GM
				Plastic fines (to identify, see CL below)			GC
	Sandy Soils More than half of coarse fraction is smaller than 4.75 mm		Clean Sands Will not leave a stain on a wet palm	Wide range in grain size and substantial amounts of all grain particle sizes.			SW
				Predominantly one size or a range of sizes with some intermediate sizes missing			SP
			Dirty Sands Will leave a stain on a wet palm	Non-plastic fines (to identify, see ML below)			SM
				Plastic fines (to identify, see CL below)			SC
Fine-Grained Soils More than half the material (by weight) is individual grains not visible to the naked eye (<0.074 mm)	Ribbon	Liquid Limit	Dry Crushing Strength	Dilatancy Reaction	Toughness	Stickiness	
	None	<50	None to Slight	Rapid	Low	None	ML
	Weak	<50	Medium to High	None to Very Slow	Medium to High	Medium	CL
	Strong	>50	Slight to Medium	Slow to None	Medium	Low	MH
	Very Strong	>50	High to Very High	None	High	Very High	CH
Highly Organic Soils	Readily identified by color, odor, spongy feel, and frequently by fibrous texture						OL OH Pt

Field Logbook Content and Control

SOP 4-1

Revision: 8

Date: February 2015

Approved:


 Signature

Technical Review:

Robert Alexander

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to set criteria for content entry and form of field logbooks. Field logbooks are an essential tool to document field activities for historical and legal purposes.

2.0 Background**2.1 Definitions**

Biota - The flora and fauna of a region.

Magnetic Declination Corrections - Compass adjustments to correct for the angle between magnetic north and geographical meridians.

2.2 Discussion

Information recorded in field logbooks includes field team names; observations; data; calculations; date/time; weather; and description of the data collection activity, methods, instruments, and results. Additionally, the logbook may contain deviations from plans and descriptions of wastes, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

3.0 General Responsibilities

Field Team Leader (FTL) - The FTL is responsible for ensuring that the format and content of data entries are in accordance with this procedure.

Site Personnel - All CDM Smith employees who make entries in field logbooks during onsite activities are required to read this procedure before engaging in this activity. The FTL will assign field logbooks to site personnel who will be responsible for their care and maintenance. Site personnel will return field logbooks to the records file at the end of the assignment.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities should be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.0 Required Equipment

- Site-specific plans
- Indelible black or blue ink pen
- Field logbook
- Ruler or similar scale

5.0 Procedures**5.1 Preparation**

In addition to this SOP, site personnel responsible for maintaining logbooks must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation requirements. These procedures should be available electronically, or located at the field office or vehicle for easy reference.

Field logbooks shall be bound with lined, consecutively numbered pages. All pages must be numbered before initial use of the logbook. Before use in the field, each logbook will be marked with a specific document control number issued by the document control administrator, if required by the contract quality implementation plan (QIP). Not all contracts require document control numbers. The following information shall be recorded on the cover of the logbook:

- Field logbook document control number (if applicable).
- Start date of entries.

Field Logbook Content and Control

SOP 4-1

Revision: 8

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- Activity (if the logbook is to be activity-specific), site name, and location.
- Name of CDM Smith contact and phone number(s) (typically the project manager).
- End date of entries.
- In specific cases, special logbooks may be required (e.g., waterproof paper for stormwater monitoring).

The first few (approximately three) pages of the logbook will be reserved for a table of contents (TOC). Mark the first page with the heading and enter the following:

Table of Contents

Date/Description (Start Date)/Reserved for TOC	Pages 1-3
---	--------------

The remaining pages of the table of contents will be designated as such with "TOC" written on the top center of each page. The table of contents should be completed as activities are completed and before placing the logbook in the records file.

5.2 Operation

Requirements that must be followed when using a logbook:

- Record work, observations, quantities of materials, calculations, drawings, and related information directly in the logbook. If data collection forms are specified by an activity-specific plan, this information does not need to be duplicated in the logbook. However, any forms used to record site information must be referenced in the logbook.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not erase or blot out any entry at any time. Indicate any deletion by a single line through the material to be deleted. Initial and date each deletion. Take care to not obliterate what was written previously.
- Do not remove any pages from the book.
- All entries must be clearly written and legible.

Specific requirements for field logbook entries include:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial and date all changes.
- Multiple authors must sign out the logbook by inserting the following:
Above notes authored by:
 - (Sign name)
 - (Print name)
 - (Date)
- A new author must sign and print his/her name before additional entries are made.
- Draw a diagonal line through the remainder of the final page at the end of the day.
- Record the following information on a daily basis:
 - Date and time
 - Name of individual making entry
 - Names of field team and other persons onsite
 - Description of activity being conducted including station or location (i.e., well, boring, sampling location number) if appropriate
 - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction, and speed) and other pertinent data
 - Level of personal protection used
 - Serial numbers of instruments
 - Equipment calibration information
 - Serial/tracking numbers on documentation (e.g., carrier air bills)

Field Logbook Content and Control

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Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the logbook must reference the automatic data record or form.

At each station where a sample is collected or an observation or measurement made, a detailed description of the location of the station is required. Use a compass (include a reference to magnetic declination corrections), scale, or nearby survey markers, as appropriate. A sketch of station location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is toward the top of the page. Maps, sketches, figures, or data that will not fit on a logbook page should be referenced and attached to the logbook to prevent separation.

Other events and observations that should be recorded include:

- Changes in weather that impact field activities.
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation.
- Problems, downtime, or delays.
- Upgrade or downgrade of personal protection equipment.
- Visitors to the site.

5.3 Post-Operation

To guard against loss of data as a result of damage or disappearance of logbooks, completed pages shall be periodically photocopied or scanned (weekly, at a minimum) and forwarded to the field or project office. Other field records shall be photocopied or scanned and submitted regularly and as promptly as possible to the office. When possible, electronic media such as flash drives or disks should be copied and forwarded to the project office. Follow the records control procedures specified in the site-specific plan.

At the conclusion of each activity or phase of site work, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated and that corrections were made properly (single lines drawn through incorrect information, then initialed and dated). The completed logbook shall be submitted to the records file.

6.0 Restrictions/Limitations

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by CDM Smith personnel and their subcontractors. They are documents that may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these logbooks should be factual, clear, precise, and nonsubjective. Field logbooks, and entries within, are not to be used for personal use.

7.0 References

EPA 2007. Contract Laboratory Program Guidance for Field Samplers. Office of Superfund Remediation and Technology Innovation. OSWER 9240.0-44. EPA 540-R-07-06. July.

US EPA. 2014. Region 4. The Field Branches Quality System and Technical Procedures, Soil Sampling. SESDPROC-010-R5. May.


Photographic Documentation of Field Activities

SOP 4-2

Revision: 9

Date: February 2015

Approved:


 Signature

Technical Review:

Robert R. Alexander

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to provide standard guidelines and methods for photographic documentation, which include digital photography and recordings of field activities and site features (geologic formations, core sections, lithologic samples, water samples, general site layout, etc.). This SOP is intended for circumstances when formal photographic documentation is required. Based on project requirements, it may not be applicable for all photographic activities.

2.0 Background

2.1 Definitions

Photographer - A photographer is the camera operator of digital photography or recordings whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

Identifier Component - Identifier components are visual components used within a photograph such as visual slates, reference markers, and pointers.

Standard Reference Marker - A standard reference marker is a reference marker that is used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

Slates - Slates are blank white index cards, marker boards, or paper used to present information pertaining to the subject/procedure being photographed. Letters and numbers on the slate will be bold and written with black indelible marking pens.

Arrows and Pointers - Arrows and pointers are markers/pointers used to indicate and/or draw attention to a special feature within the photograph.

Contrasting Backgrounds - Contrasting backgrounds are backdrops used to lay soil samples, cores, or other objects on for clearer viewing and to delineate features.

Date Stamp - A date stamp is a built-in feature that will record the date and time directly on a digital image or recording.

2.2 Associated Procedures

- SOP 4-1, *Field Logbook Content and Control*

2.3 Discussion

Digital photographs and recordings made during field investigations are used as an aid in documenting and describing site features, sample collection activities, equipment used, and possible lithologic interpretation. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard reference markers, and pointers. The use of a photographic logbook and standardized entry procedures are also outlined. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the images or recordings and ensure the representative nature of the photographic documentation.

3.0 General Responsibilities

Field Team Leader - The field team leader (FTL) is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The FTL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

Photographic Documentation of Field Activities

SOP 4-2

Revision: 9

Date: February 2015

Photographer - The photographer shall seek direction from the FTL and regularly discuss the visual documentation requirements and schedule. The photographer is responsible for maintaining a logbook per Sections 5.1, 5.2.4, and 5.3.1 of this SOP. Responsibilities will be defined in the project sampling plan.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site/quality assurance project plan (QAPP).

4.0 Required Equipment

A general list of equipment that may be used:

- Digital camera and appropriate storage media
- Extra batteries for camera
- Digital video camera and appropriate storage media (e.g., SD card)
- Logbook
- Indelible black or blue ink pen
- Standard reference markers (e.g. ruler)
- Slates or marker boards
- Arrows or pointers
- Contrasting backgrounds
-
-
-

5.0 Procedures

5.1 Documentation

Documentation requirements for digital photographs and recordings should be specified in the site-specific plan. Otherwise, a commercially available, bound logbook will be used to log and document photographic activities. Review SOP 4-1, *Field Logbook Content and Control* and prepare all supplies needed for logbook entries.

Note: A separate photographic logbook is not required. A portion of the field logbook may be designated as the photographic log and documentation section.

Field Health and Safety Considerations

There are no hazards that an individual will be exposed to specific to photographic documentation. However, site-specific hazards may arise depending on location or operation. Personal protective equipment used in this operation will be site-specific and dictated through requirements set by the site safety officer, site health and safety plan, and/or prescribed by the CDM Smith Corporate Health and Safety Program. The photographer should contact the site safety officer for health and safety orientation before commencing field activities. The site health and safety plan must be read before entry to the site, and all individuals must sign the appropriate acknowledgement that this has been done.

The photographer should be aware of any potential physical hazards while photographing the subject (e.g., traffic, low overhead hazard, edge of excavation).

5.2 Operation

5.2.1 General Photographic Activities in the Field

The following sections provide general guidelines that should be followed to visually document field activities and site features using digital still and video cameras. Listed below are general suggestions that the photographer should consider when performing activities under this SOP:

- The photographer should be prepared to make a variety of shots, from close-up to wide-angle. Many shots will be repetitive in nature or format, especially close-up site feature photographs. Consideration should therefore be given to designing a system, camera settings, or technique that will provide a reliable repetition of performance.

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- No preference of digital storage medium is specified and is left to the discretion of the photographer.
- Digital cameras have multiple photographic quality settings. A camera that obtains a higher resolution (quality) has a higher number of pixels and will store a fewer number of photographs per digital storage medium. Project resolution requirements should be determined prior to implementing field work.

5.2.2 General Guidelines for Still Photography

Caption Information

Unless otherwise specified in a site-specific plan, all still photographs will have a full caption added after the images are downloaded on a photo log sheet. The caption should contain the following information:

- Photograph sequence number
- Date and time
- Photographer
- Description of activity/item shown (e.g., name of facility/site, specific project name, project number)
- Direction (if applicable)

When directed by the sampling plan, a standard reference marker should be used in all documentary visual media. While the standard reference marker will be predominantly used in close-up feature documentation, inclusion in all scenes should be considered.

Digital images should be downloaded at least once each day to a personal computer; the files should be in either "JPEG" or "TIFF" format. Files should be renamed at the time of download to correspond to the logbook or as directed in the site-specific plan. It is recommended the electronic files be copied to a compact disc for backup.

Close-Up and Feature Photography

When directed by the sampling plan, close-up photographs should include a standard reference marker of appropriate size as an indication of the feature size and contain a slate or marker board marked with the site name and any identifying label, such as a well number or core depth, that clearly communicates to the viewer the specific feature being photographed.

Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their in situ locations. This enables a more accurate record of their initial condition and color. When directed by the sampling plan, include a standard reference color strip (color chart such as Munsell Soil Color Chart) within the scene. This is to be included for the benefit of the viewer of the photographic document and serves as a reference aid to the viewer for formal lithologic observations and interpretations.

Site Photography

Site photography, in general, will consist predominantly of medium- and wide-angle shots. If required by the sampling plan, a standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane.

While it is encouraged that a standard reference marker and slate/marker board be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the image number shall be entered in the photographic logbook along with other information pertinent to the scene.

5.2.3 General Photographic Documentation Using Digital Video Cameras

Documentary digital recordings of field activities may include an audio slate for all scenes. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account may include any additional information clarifying the subject matter being recorded.

Photographic Documentation of Field Activities

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A standard reference marker may be used when taking close-up shots of site features with a video camera. The scene may also include a caption/slate. It should be placed adjacent and parallel to the feature being photographed.

It is recommended that a standard reference marker and slate/marker board be included in all scenes. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original video recordings will not be edited. This will maintain the integrity of the information contained on the videotape or DVD. If editing is desired, a working copy of the original video recording can be made.

A digital recording filename should be created with the appropriate identifying information (project name, project number, date, location, etc.).

5.2.4 Photographic Documentation

If required by the site-specific plan, photographic activities must be documented in a photographic logbook or in a section of the field logbook. The photographer will be responsible for making proper entries.

In addition to following the technical standards for logbook entry as referenced in SOP 4-1, the following information should be maintained in the appropriate logbook:

- Photographer name.
- Sequential tracking number for each photograph taken (the camera-generated number may be used).
- Date and time (military time).
- Location.
- A description of the activity/item photographed.
- If needed, a description of the general setup, including approximate distance between the camera and the subject, may be recorded in the logbook.
- Record as much other information as possible to assist in the identification of the photographic document.

5.3 Post Operation

The photographer shall be responsible for downloading image files or recordings to the project files.

As required, the photographer(s) will ensure that the appropriate logbook has been completely filled out and maintained as outlined in SOP 4-1. Images and recordings will be handled according to contract records requirements. The project manager will ensure their proper distribution. Completed pages of the appropriate logbook will be copied weekly and submitted to the project files.

6.0 Restrictions/Limitations

This document is designed to provide a set of guidelines to ensure that an effective and standardized program of visual documentation is maintained.

It is not within the scope of this document to provide instruction in photographic procedures, nor is it within the scope of this document to set guidelines for presentation or "show" photography.

The procedures outlined herein are general by nature. The photographer is responsible for specific operational activity or procedure described in site-specific plans. Questions concerning specific procedures or requirements should be directed to the project manager or FTL.

Note: Some sites do not permit photographic documentation. Check with the site contact for any restrictions.

Photographic Documentation of Field Activities

SOP 4-2

Revision: 9

Date: February 2015

7.0 References

U. S. Army Corps of Engineers. 2001. *Requirements for the Preparation of Sampling and Analysis Plans*, EM 200-1-3. Appendix F. February.

U. S. Environmental Protection Agency. 1992. National Enforcement Investigations Center. *Multi-Media Investigation Manual*, EPA-330/9-89-003-R. p. 85. Revised March.

_____. 2013. Region 4. The Field Branches Quality System and Technical Procedures, Soil Sampling. SESDPROC-005-R2. January.

Well Development and Purging

SOP 4-3

Revision: 7

Date: February 2015

Approved:



Signature

Technical Review:

David Schroeder

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to define the procedural requirements for well development and purging.

2.0 Background

Monitoring wells are developed to repair damage to the formation caused by drilling activities and to settle and remove fines from the filter pack. Wells shall not be developed for at least 24 to 48 hours after completion when a cement bentonite grout is used to seal the annular space; however, wells may be developed before grouting if conditions warrant. Wells are purged immediately before groundwater sampling to remove stagnant water and to sample representative groundwater conditions. Wells shall be sampled within 3 hours of purging (optimum) to 24 hours after purging (maximum, for low recharge conditions).

2.1 Associated Procedures

- SOP 1-6, *Water Level Measurement*
- SOP 4-1, *Field Logbook Content and Control*
- SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

3.0 General Responsibilities

Site Manager - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that development and purging are carried out in accordance with this procedure.

Field Team Leader - The field team leader is responsible for complying with this procedure.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment**4-1 General**

- Pump, pump tubing, or bailer and rope or wire line
- Power source (e.g., generator), if required
- Electronic water-level meter
- Temperature, conductivity, pH, and turbidity meters
- Personal protective equipment as specified in the site-specific health and safety plan
- Decontamination supplies, as required, according to SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*
- Disposal drums, if required
- Photoionization detector (PID) or equivalent as specified in site-specific health and safety plan

5.0 Procedures**5.1 Well Development**

The following steps must be followed when developing wells:

1. Review site-specific health and safety plan and project plans before initiating sampling activity.
2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

Well Development and Purging

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3. Open the well cover and check condition of the wellhead, including the condition of the surveyed reference mark, if any.
4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.
5. Determine the depth to static water level and depth to bottom of the well (SOP 1-6).
6. Prepare the necessary equipment for developing the well. There are a number of techniques that can be used to develop a well. Some of the more common methods are bailing, overpumping, backwashing, mechanical surging, surge and pump, wire brush, swabbing, and high-velocity jetting. All of these procedures are acceptable; however, final approval of the development method rests with the appropriateness of a specific method to the geologic conditions, well type and approved work plans, field sampling plans, etc.
7. For screened intervals longer than 10 feet (3 meters [m]), develop the well in 2- or 3-foot (0.75- or 1-m) intervals from bottom to top. This will ensure proper packing of the filter pack.
8. Continue well development until produced water is clear and free of suspended solids, as determined by a turbidity meter or when pH, conductivity, and temperature have stabilized. Record pertinent data in the field logbook and on appropriate well development forms. Remove the pump assembly or bailers from the well, decontaminate (if required), and clean up the area. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

5.2 Volumetric Method of Well Purging

The following steps shall be followed when purging a well by the volumetric method:

1. Review site-specific health and safety plan and project plans before initiating well purging activity.
2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.
3. Open the well cover and check condition of the wellhead, including the condition of the surveyed reference mark, if any.
4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.
5. Determine the depth to static water level and depth to bottom of well casing according to SOP 1-6, *Water Level Measurement*. Calculate the volume of water within the well bore using the following formula (or equivalent):

$$7.4805 \left[\frac{D^2 \pi}{(4)} \right] dH = \text{volume (in gallons)}$$

where

D = casing diameter in feet. (**Note:** This equation is used for grouted wells with short screens. For wells with long screens and/or ungrouted wells, the D = borehole diameter in feet).

dH = the distance from well bottom to static water level in feet.

$\pi = 3.1416$.

Alternatively, the volume may be determined using a casing volume per foot factor for the appropriate diameter well, similar to that in Table 1. The water level is subtracted from the total depth, providing the length of the water column. This length is multiplied by the factor in Table 1 corresponding to the appropriate well diameter, providing the amount of water, in gallons, contained in the well.

Well Development and Purging

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TABLE 1
WELL CASING DIAMETER vs. VOLUME

WELL CASING DIAMETER (inches) vs. VOLUME (gals.)/FEET of WATER	
CASING	GALLONS/FT
1	0.041
2	0.163
3	0.367
4	0.653
5	1.02
6	1.469
7	1.999
8	2.611
9	3.305
10	4.08
11	4.934
12	5.875

Note: Record all data and calculations in the field logbook.

6. Prepare the pump and tubing, or bailer, and lower it into the casing.
7. Remove the number of well volumes specified in the site-specific plans. Generally, three to five well volumes will be required. Conductivity, pH, temperature, and turbidity shall be measured and recorded. Purging shall continue until the field parameters have stabilized. Groundwater quality parameters are considered stable when three consecutive readings are within ± 0.1 for pH, ± 3 percent for conductivity, ± 10 mv for redox potential (ORP), and ± 10 percent for turbidity if greater than 10 NTU, in accordance with site-specific plans. Efforts shall be made to get turbidity below 10 NTU, especially if groundwater samples are to be collected for metals or PCB analyses.
8. In low recharge aquifers, the following steps shall be followed: (1) If the initial water level is less than 10 feet above the top of the screen, then purge to dryness and allow sufficient recharge to collect samples. (2) If initial water level in the well is more than 10 feet above the top of the screen, then care shall be taken to prevent the dewatering of the screened interval. (3) Continue purging until the water level is between 1 and 5 feet above the top of the screen. (4) Allow well to recharge then continue purging until at least 1 full initial well volume has been purged. (5) Record pertinent data in the field logbook.
9. Groundwater sampling shall be performed immediately upon completion of purging (unless time for recharge is required for low-recharge wells) using the same equipment that was used for purging. Unfiltered samples shall be collected first, beginning with volatile organic compounds (VOCs). After all unfiltered samples have been collected, a 0.45 micron in-line filter shall be installed in the discharge line for collection of filtered samples, if required.
10. After sampling activities have been completed, remove the pump assembly or bailer from the well, decontaminate it (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plan.

5.3 Indicator Parameter Method of Well Purging

1. Review site-specific health and safety plan and project plans before initiating well purging activity.
2. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.
3. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.

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4. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.
5. Determine the depth to static water level and depth to bottom. Set up surface probe(s), (e.g., pH, conductivity) at the discharge orifice or dedicated probe port of the pump assembly or within the flow-through chamber. Allow probe(s) to equilibrate according to manufacturer's specifications. Record the equilibrated readings in the field logbook.
6. Assemble the pump and tubing and lower into the casing.
7. Begin pumping or bailing the well. Record indicator parameter readings for every 5 minutes or purge volume, whichever is sooner. Maintain a record of the approximate volumes of water produced. Care shall be taken to minimize drawdown (0 to 0.2 feet).
8. Continue pumping or bailing until indicator parameter readings remain stable within ± 0.1 for pH, ± 3 percent for conductivity, ± 10 mv for redox potential (ORP), and ± 10 percent for turbidity if greater than 10 NTU for three consecutive recording intervals and a minimum of 1 well volume is removed, or in accordance with site-specific plans. Purging shall continue until the discharge stream is clear or turbidity becomes asymptotic-low or meets project requirements.
9. For a low recharge aquifer, follow the guidelines of Section 5.2, Paragraph 7.
10. Groundwater sampling shall be performed immediately upon completion of purging (unless time for recharge is required for low-recharge wells) using the same equipment that was used for purging. Unfiltered samples shall be collected first, beginning with VOCs. After all unfiltered samples have been collected, a 0.45 micron in-line filter shall be installed in the discharge line for collection of filtered samples, if required.
11. Remove the pump assembly or bailer from the well, decontaminate (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

6.0 Restrictions/Limitations

Where flammable, free, or emulsified product is expected, or known to exist on or in groundwater, use intrinsically safe electrical devices only and place portable power sources (e.g., generators) 50 feet (15 m) or further from the wellhead and disposal drums.

7.0 References

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U. S. Army Corps of Engineers. 1998. *Monitoring Well Design, Installation, and Documentation at Hazardous Toxic, and Radioactive Waste Sites*, EM 1110-1-4000, Chapter 6. November 1.

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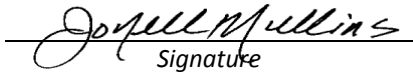
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Date: February 2015

Approved:


Signature

Technical Review:

Michael Valentino

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to provide guidelines for the installation of groundwater monitoring wells. These guidelines will help to produce consistency of approach in the design and installation of monitoring wells. Individual installations will probably vary in some respects since they may encounter differing hydrogeologic conditions.

2.0 Background

2.1 Definitions

Monitoring Well Installation - The act of installing well casing, screen, filter pack, bentonite seal, grout, and other specified materials in a borehole to construct a complete monitoring well.

2.2 Associated Procedures

- SOP 3-5, *Lithologic Logging*
- SOP 4-1, *Field Logbook Content and Control*
- SOP 4-2, *Photographic Documentation of Field Activities*
- SOP 4-3, *Well Development and Purging*
- SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

This SOP is intended to cover the installation of monitoring wells for use in conducting a variety of environmental investigations. It is intended to be a general guideline listing the types of materials and methods to be considered when a well is installed. Materials are not specified in detail since it is likely there will be wide variability required to meet the needs of individual site conditions or specific clients. Ideally, the well shall not alter the medium that is being sampled.

3.0 General Responsibilities

Site Manager - Translates client's requirements into technical direction of project. Sets technical criteria, reviews and approves technical progress, and ensures that all participating personnel have proper training. **Note:** Other titles such as project manager may be used.

Field Team Leader (FTL) - Supervises field operations. Ensures that all necessary equipment including safety equipment is available and functioning properly before project operations begin. Ensures that all necessary personnel are mobilized on time. Maintains daily log of activities each work day.

Field Geologist - Collects and maintains data and completes Monitoring Well Construction Forms. Coordinates and consults with site manager on decisions relative to unexpected encounters during well installation and deviation from this SOP. Directs overall activities of drill and support subcontractors.

Drilling Subcontractor - Provides necessary personnel, equipment, and services to meet terms of the contract.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

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4.0 Required Equipment and Materials

4.1 Required Equipment

- Field logbook
- Monitoring Well Construction Forms
- Measuring tape

4.2 Required Construction Materials

General - The materials that are used in the construction of a monitoring well and that come in contact with the groundwater shall not measurably alter the chemical quality of a groundwater sample. The well casing and well screen shall be steam cleaned (if appropriate for the selected material) before well installation or certified clean from the manufacturer and delivered to the site in protective wrapping. If required by the site specific plans, samples of the cleaning water, drilling fluids, filter pack, annular seal, and mixed grout may be retained to be analyzed if groundwater contamination as the result of well installation is suspected. If required, these samples can serve as quality control checks until the completion of at least one round of groundwater quality sampling and analysis.

Water - Water, which may be used in the well completion process, shall be obtained from a source that does not contain constituents that could compromise the integrity of the well installation. If required by the site specific plans, a certificate of analysis shall be provided with the water, or a sample of the water shall be analyzed and documented as contaminant-free.

Surface (Isolation) Casing - Surface, or isolation, casing may be required to isolate an upper aquifer while drilling and installing deep wells. The isolation casing usually consists of black steel or polyvinyl chloride (PVC). Surface casings shall be large enough to allow a minimum annular space of 2 inches between it and the well casing. Segments of black steel casings are typically welded together as the casing is lowered down the borehole. PVC isolation casings are either flush-threaded or have a bell shape at one end so that sections slip together and are held with small stainless steel screws. Casings shall be grouted in place and allowed to set for 12 to 24 hours before advancing the borehole below the surface casing.

Well Screen - The well screen shall be new and composed of materials most suited for the environment being monitored. The screened interval shall be plugged at the bottom. The plug shall be of the same material as the bottom section of screen and shall be securely attached, making a positive seal. This assembly must have the capability to withstand well installation and development stresses without becoming dislodged or damaged. The length of the well screen slotted area shall be appropriate for the interval to be monitored including some allowance for changes in elevation of the water table. Before installation, the casing string and associated equipment shall be cleaned with steam or high-pressure hot water, if not certified cleaned. Well screens shall be stainless steel or PVC, as appropriate. Fluoropolymer materials may be substituted if necessary because of the potential for incompatible chemical reactions between contaminants and the stainless steel screen, or if stainless steel constituents are possible site contaminants. The minimum inside diameter of the well screen shall be chosen based on the particular application. Well screens shall be flush threaded per American Society for Testing and Materials (ASTM) standards. Glued or solvent-welded joints may not be used since glues and solvents may alter the chemistry of the water samples.

The slot size of the well screen shall be determined relative to the grain-size analysis of the stratum to be monitored and the gradation of the filter pack material. In granular, noncohesive, strata that falls in easily around the screen, filter packs may not be necessary. In these cases of natural development, the slot size of the well screen is to be determined using the grain size of the surrounding strata. The slot size and arrangement shall retain at least 90 percent of the filter pack.

Casing - The well casing will be PVC, stainless steel, or some other appropriate material and will extend from the screen to the surface. The type of casing and wall thickness shall be adequate to withstand the forces of installation. Several different casing sizes may be required depending on the subsurface geologic conditions. The diameter of the casing for filter packed wells shall be selected so that a minimum annular space of 2 inches is maintained between the casing and the borehole wall. The diameter of the casings in multi-cased wells shall be selected so that a minimum annular space of 2 inches is maintained between casing strings and between the outer casing and the borehole (e.g., a 2-inch-diameter well screen will require first setting a 6-inch-diameter casing in a 10-inch-diameter boring). Under difficult drilling conditions (collapsing soils, rock, or cobbles), it may be necessary to advance temporary casing. Under these conditions, a smaller space may be maintained. The ends of each casing section shall be flush-threaded.

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Primary Filter Pack - The primary filter pack (sand or gravel pack) consists of a clean, well-sorted, rounded granular material of selected grain size and gradation that is installed in the annulus between the screened interval and the borehole wall. The filter pack may be installed along the screened interval using a tremie pipe from the total depth of the well to the designated distance above the top of the screened interval. A filter pack material mostly consisting of siliceous, rather than calcareous, particles is preferred. Select the grading of the filter pack on the basis of the layer of finest material to be screened. A minimum filter pack thickness shall be between 2 to 3 inches and generally shall never be greater than 8 inches. The filter pack shall extend at least 2 to 3 feet above the screened interval or more depending on the screen length to provide for filter pack settlement.

Transition Sand - A layer of fine to very fine sand may be placed on top of the primary filter pack before emplacement of the bentonite seal. The sand shall be of sufficient thickness to prevent bentonite from penetrating to the vicinity of the well screen during placement of the bentonite seal.

Annular Sealants - The materials used to seal the annulus may be prepared as a slurry or used unmixed in a dry pellet form. Sealants shall be selected for compatibility with local geologic, hydrogeologic, climatic, and human-induced conditions anticipated to occur during the life of the well.

Grout - The grout backfill that is placed above the bentonite annular seal shall be a liquid slurry consisting of water, bentonite grout of Volclay or equivalent quality, and portland cement. Bentonite-based grouts are typically used when a more flexible grout is desired (i.e., freeze-thaw). Cement-based grout provides a more rigid installation. A typical bentonite grout mixture is 1 to 1.25 pounds bentonite to 2 pounds of Type I portland cement per gallon of water. Cement-based grout is typically 6 to 7 gallons of water per 94 pound bag of Type I portland cement and 2.7 percent bentonite powder.

Bentonite - Bentonite shall be powdered or pelletized sodium montmorillonite furnished in sacks or buckets from a commercial source and free of impurities that adversely impact water quality in the well. The diameter of pellets selected for monitoring well construction shall be less than one-fifth the width of the annular space into which they are placed to reduce the potential for bridging. Pellets are typically used for placing annular seals, and powdered bentonite is used for mixing in grout slurry.

Cement - Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement shall generally be portland Type I, Type II, or Type I/II as specified in ASTM C 150. Quick-setting cements containing additives are not allowable for use in monitoring well installation. Additives may leach from the cement and influence the chemistry of the groundwater.

Annular Seal Equipment (Tremie Pipe) - A tremie pipe is used to inject the annular seals and filter pack. Tremie pipes are typically constructed of PVC or galvanized steel. Associated equipment may include a trough or mixing box and "mud pump" to place the material.

Protective Casing - Protective casings are installed on wells placed in overgrown or nontraffic areas. The casings may be made of galvanized steel (or rarely stainless steel) and shall have a lid capable of being secured by a locking device. The inside dimensions of the protective casing shall be at a minimum 4 inches larger than the diameter of the casing to facilitate the installation and operation of sampling equipment. Protective casing shall extend approximately 2 to 3 feet into the ground to anchor it securely. Protective casings are typically set in concrete pads measuring 2 feet x 2 feet to 4 feet x 4 feet and 4 to 6 inches thick depending on client requirements.

Flush-Mount Protective Covers - Flush-mount covers (Christy boxes) are installed over wells placed in paved or manicured areas. The covers are typically 8 inches in diameter with a 1-foot galvanized steel skirt and cast iron bolt-down ring and lid. The covers are installed in concrete pads measuring 2 to 3 feet square that are constructed so as to not impede vehicle traffic and sloped from the center toward the edges to prevent infiltration of run-off water.

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5.0 Procedures

5.1 Drilling Methods

The actual methods of drilling at a site will vary depending on site conditions. The method to be used at a site shall be stated in the site-specific plans. Deviations from the methods prescribed in these plans shall be approved by the FTL or designee. Typical drilling methods include air rotary or hammer, mud/fluid rotary, roto-sonic, and hollow-stem auger. Drilling with mud or water is least desirable, but the driller shall have the capability to use this method if borehole conditions warrant it. Installation of isolation casing, if required, shall be done by either penetrating the outer casing into the ground by hammer blows or by drilling a borehole. The outer casing shall be set and secured by grouting or other means specified in the site-specific plans. The inner well borehole can then be drilled through the center of the outside casing. The monitoring wells shall be drilled vertical or at an angle if specified in the site-specific plans. The wells shall be drilled to a depth specified in the site-specific plans and may vary based on actual lithologic conditions. The depth to completion shall be approved by the FTL or designee before monitoring well construction. Drillers must prevent grease, oil, and other fluids from the drill rig from coming in contact with the ground around the area of well installation. If air is used during the drilling process (e.g., air rotary), the air supply must be free of oils to prevent introducing contamination to the borehole and groundwater system. This can be accomplished by installing an approved air filter in-line between the air compressor and the air discharge.

Collection of continuous core may be required during borehole drilling. Samples may be collected by several methods depending on project needs and the material being sampled including split-spoon sampler, direct-push, or sonic coring (unconsolidated material), or wire-line coring (bedrock). A description of soil/lithologic materials and drilling observations needs to be recorded on a boring log or in a logbook (SOP 3-5).

5.2 Monitoring Well Installation

5.2.1 Stable Borehole

A stable borehole must be constructed before attempting to install the monitoring well. Steps must be taken to stabilize the borehole before attempting installation if the borehole tends to cave or blow-in, or both. Boreholes that are not straight or are partially obstructed shall be corrected before attempting the installations described herein.

Although all monitoring wells will not be completed exactly alike, there are common elements among them. The Monitoring Well Construction Form(s) (Figures 1, 2, 3, and 4 or equivalent) must be completed by the end of the activity with data obtained through the installation process. Modification of the construction and dimensions on the Well Construction Forms may be needed depending on site-specific conditions. The well construction field form shall be reviewed before initiation of drilling activities to ensure that the required data are collected at appropriate times during drilling and installation.

5.2.2 Well Casing Assembly

The well screen, casing, and bottom plug shall be either certified clean from the manufacturer or decontaminated according to SOP 4-5.

The casing shall be flush-threaded, using Schedule 40 PVC or other suitable monitoring well casing. No adhesives, cements, or lubricants shall be used during casing make-up or during other drilling and well completion operations. Personnel shall take precautions to ensure that grease, oil, or other contaminants that may alter water samples do not contact any portion of the well casing assembly. As a precaution, personnel shall wear a pair of clean gloves while handling the assembly.

Normally, couplings are tightened by hand; however, steam- or high-pressure-cleaned strap wrenches may also be used. Use pipe wrenches with care as they may scar and weaken the pipe. Precautions shall be taken to prevent damage to the threaded joints during installation.

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5.2.3 Setting the Well Screen and Casing Assembly in Fluid Filled Holes

When the well screen and casing assembly is lowered to the predetermined level and held in position, the assembly may require a ballast to counteract the tendency to float in the borehole. Ballasting may be accomplished by continuously filling the casing assembly with contaminant-free water. If fluid ballasts are used, the quantity introduced must be recorded in the field logbook. Alternatively, the casing assembly may be slowly pushed into the fluid in the borehole with the aid of hydraulic rams on the drill rig and held in place as additional sections of casing are added to the column. Care must be taken to secure the casing assembly so that personnel safety is ensured during the installation. For wells greater than 100 feet, the assembly shall be installed straight using centralizers at selected intervals.

The casing shall extend to grade or approximately 2 feet above grade, depending on the intended surface completion, and be capped or covered temporarily to deter entrance of foreign materials during completion operations.

5.2.4 Installation of the Primary Filter Pack

Placement of the casing assembly is followed by placing the primary filter pack (consisting of silica sand sized according to the average grain size of the screened formation) into the bottom of the borehole by using a tremie pipe. The primary filter pack is placed in increments as the tremie is gradually raised. The sand pack will be emplaced by the "washdown" gravity method and the depth to the top of the sand pack shall be determined and recorded frequently during the operation to ensure proper placement. The tremie pipe or a weighted line inserted through the tremie pipe can be used to measure the top of the primary filter pack as work progresses. As primary filter pack material is poured into the tremie pipe, potable water is used to help move the sand through the tremie pipe. The quantity of water introduced shall be recorded in a field logbook. If bridging of the primary filter pack occurs, the bridged material shall be broken mechanically before proceeding with the addition of more filter pack material. The depth, volume, and gradation of the primary filter pack will be recorded on the well construction diagram.

Some primary filter pack installations can be accomplished without the use of a tremie pipe. In these instances the filter pack is slowly poured into the borehole from the surface being careful to avoid bridging of the sand as it falls through the water column in the borehole. If this approach is used a weighted tape measure should be lowered into the borehole annulus to measure the increasing height of the filter pack as sand is added to the borehole, making sure to keep the tape measure moving in an up and down motion so the tape does not become buried in the filter pack.

If possible, measuring tape soundings shall be made to ensure the level of the filter pack is in agreement with the calculated volume and that the desired placement is achieved.

If used, temporary casing or auger sections will be withdrawn in increments as the sand pack is emplaced. Care shall be taken to minimize lifting the casing with the withdrawal of the temporary casing/augers. To limit borehole collapse, the temporary casing or hollow-stem auger is usually withdrawn until the lowermost point on the temporary casing or hollow-stem auger is at least 2 feet, but no more than 5 feet, above the filter pack for unconsolidated materials; or at least 5 feet, but no more than 10 feet, for consolidated materials. Ascertain the depth of the sand with an acceptable measuring device or with tremie pipe and verify the thickness of the sand pack. The primary filter pack is typically placed a minimum of 2 feet above the top of the well screen to account for settlement of the filter pack. The volume and depth of the filter pack material shall be measured and recorded on the well construction diagram.

5.2.5 Installation of the Bentonite Seal

A minimum 2-foot-thick bentonite seal shall be emplaced on top of the filter pack or transition sand (if used) and is generally emplaced by gravity feed. The bentonite shall be slowly fed into the annulus and carefully monitored to ensure that bridging is not taking place. Time-release pellets coated with a food-grade coating must be used in deep well applications to prevent premature expansion of the bentonite.

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Some clients may require installing the bentonite seal by using a tremie pipe. This type of installation shall be accomplished by washing the bentonite pellets through the tremie pipe with potable water. If the tremie pipe becomes plugged, requiring an increase in pressure to clear it, not less than 20 feet of tremie pipe shall be pulled up to avoid jetting into the sand pack. If the seal is installed above the water level, water shall be added to allow proper hydration of the annular seal (approximately 1 gallon for each linear foot of annular seal). The volume and depth of the bentonite seal material shall be measured and recorded on the well construction diagram.

If possible, measuring tape soundings shall be made to ensure the level of the bentonite seal is in agreement with the calculated volume and that the desired placement is achieved.

5.2.6 Grouting the Annular Space

The following procedures apply to both single- and multi-cased monitoring wells. However, it shall be noted that grouting procedures will vary with the type of well design.

A sufficient volume of grout shall be premixed onsite, according to procedure stipulated by the manufacturer, to compensate for unexpected losses and checked against the known volume of annular space to ensure that bridging does not occur during emplacement. The use of alternate grout materials, including grout containing portland cement, may be necessary to control zones of high grout loss. The mixing (and placing) of grout shall be performed with recorded weights and volumes of materials, according to procedures stipulated by the manufacturer. Lumpy grout shall not be used in an effort to prevent bridging within the tremie and the well. Bentonite-based grout of Volclay or equivalent type shall be mixed to the manufacturer's specifications then pumped into place using minimum pump pressure. All additives to grouts shall be evaluated for their effects on subsequent water samples.

Depending upon the well design, grouting may be accomplished using a pressure grouting technique or by gravity feed through a tremie pipe. With either method, grout is introduced in one continuous operation until grout flows out at the ground surface without evidence of drill cuttings or fluid. The grout backfill shall be injected under pressure using a tremie pipe to reduce the possibility of leaving voids in the annular seal and to displace any liquids and drill cuttings that may remain in the annulus.

Grouting shall begin directly above the bentonite seal, after the bentonite has been adequately hydrated. Grout shall be injected using a tremie pipe. The tremie pipe shall be kept full of grout from start to finish with the discharge end of the pipe completely submerged as it is slowly and continuously lifted. Pump pressure shall be kept to a minimum. Approximately 5 to 10 feet of tremie pipe shall remain submerged during grout emplacement. A staged grouting procedure may be considered if the couplings of the selected casing cannot withstand the shear or if there is collapse stress exerted by the full column of grout as it sets. If used, the temporary casing or hollow-stem auger shall be removed in increments (immediately following each lift of grout installation) well in advance of the time when the grout begins to set. The initial grout mixture must be allowed to cure for at least 12 hours, before attempting to refill (top off) the grout to the surface.

The well shall not be developed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and casing. The amount of time required (generally 24 to 48 hours) will vary with grout content and climate conditions and shall be documented on the well completion diagram along with the volume and depth of grout used to backfill the annular space.

5.3 Well Protection

Well protection refers specifically to installations made at or above the ground surface to deter unauthorized entry to the monitoring well, prevent damage, and to prevent surface water from entering the annulus.

The protective casing shall extend from below the frost line (at least 2 feet below grade) to slightly above the well casing top. The protective casing shall be sealed and immobilized in concrete that has been placed around the outside of the protective casing above the set grout backfill. The casing shall be positioned and stabilized in a position concentric with the casing. Clearance (usually 6 inches) shall be maintained between the lid of the protective casing and the top of the casing to accommodate sampling equipment. A ¼-inch-diameter weep hole shall be drilled in the protective casing at the ground surface to permit water to drain out of the annular space. This hole will also prevent water freezing between the well protector and the well casing.

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All materials used shall be documented on the well construction diagram. The monitoring well identification number shall be clearly visible on the inside and outside of the lid of the protective casing and the outside of the protective casing.

A 3-feet x 3-feet x 6-inch-thick concrete pad, sloped to provide water drainage away from the well, may be placed around the installation. Pad size may vary according to site conditions or client specifications. Three to four 2½-inch-diameter concrete-filled steel posts set at least 24 inches below the surface in concrete shall be equally spaced around the well to protect against damage by vehicular traffic for aboveground well completions. The protective casing and steel posts may be primed and painted with rust-resistant yellow paint. The annulus between the well casing and the protective casing may be filled with sand to approximately 1 foot below the top of the well casing to help stabilize the well casing and prevent the loss of tools or equipment in the annular space.

A flush-mounted, traffic-rated casing or vault is typically used for the surface completion of monitoring wells installed in high-use paved or maintained grass (landscaped) areas. The well box cover shall be finished slightly above pavement or ground surface to prevent water entry. A layer of sand or gravel material shall be placed under the casing/vault to allow infiltrating surface water to drain out.

5.4 Post Operation

5.4.1 Field

At the conclusion of the monitoring well installation activities, all equipment must be decontaminated (according to SOP 4-5) before moving the equipment to a different work location. All water used in the decontamination of drilling equipment will be contained in an appropriate container, if required in the site-specific plans.

5.4.2 Documentation

The Groundwater Monitoring Well Construction Form (Figures 1, 2, 3, and 4 or equivalent) shall be completed by the FTL or designee at the conclusion of the field activity.

Copies of all field notes, the daily logs, and any completed Groundwater Monitoring Well Construction Forms shall be given to the site manager. These records shall be maintained in the project and document control files. At a minimum, all materials used for construction shall be documented by entering identifying numbers (lot numbers, manufacturer's identification, etc.) in the field logbook. Samples of well materials (including grout, sand, etc.) may be archived if specified in the project plans.

6.0 Restrictions and Limitations

None.

7.0 References

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Figure 1

Typical Construction Detail of Above-Grade Single-Cased Monitor Well (Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. _____

BORING DATA
 TOTAL DEPTH OF BOREHOLE _____
 HOLE DIAMETER _____
 DRILLING METHOD _____

CONSTRUCTION DATA
 CASING LENGTH _____
 CASING DIAMETER _____
 CASING MATERIAL _____
 JOINT DESIGN _____
 SEAL _____
 FILTER PACK _____
 SCREEN SIZE _____
 SCREEN MATERIAL _____

A. CASING ELEVATION ABOVE GROUND _____
 B. DEPTH TO TOP OF CASING _____
 C. DEPTH OF TOP OF GROUT _____
 D. DEPTH TO TOP OF BENTONITE _____
 E. DEPTH TO TOP OF SAND _____
 F. DEPTH TO TOP OF SCREEN _____
 G. TOTAL WELL DEPTH _____
 H. WATER FIRST NOTICED _____
 I. DEPTH TO WATER AT COMPLETION _____

CLIENT _____
 DRILLING CONTRACTOR _____
 DRILL RIG _____
 DRILLERS _____
 INSTALLATION DATE _____
 LOGGED BY _____

NOT TO SCALE

Details of Monitoring Well _____
 Project _____
 Project Location _____

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Figure 2

**Typical Construction Detail of Flush-Mount Single-Cased Monitor Well
(Not to Scale - Shown as an Example Only)**

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MONITOR WELL CONSTRUCTION DETAILS

WELL NO. _____

BORING DATA

TOTAL DEPTH OF BOREHOLE _____

HOLE DIAMETER _____

DRILLING METHOD _____

CONSTRUCTION DATA

CASING LENGTH _____

CASING DIAMETER _____

CASING MATERIAL _____

JOINT DESIGN _____

SEAL _____

FILTER PACK _____

SCREEN SIZE _____

SCREEN MATERIAL _____

A. CASING ELEVATION
ABOVE GROUND _____

B. DEPTH TO TOP OF CASING _____

C. DEPTH OF TOP OF GROUT _____

D. DEPTH TO TOP OF FINE SAND _____

E. DEPTH TO TOP OF SAND _____

F. DEPTH TO TOP OF SCREEN _____

G. TOTAL WELL DEPTH _____

H. WATER FIRST NOTICED _____

I. DEPTH TO WATER AT
COMPLETION _____

CLIENT _____

DRILLING CONTRACTOR _____

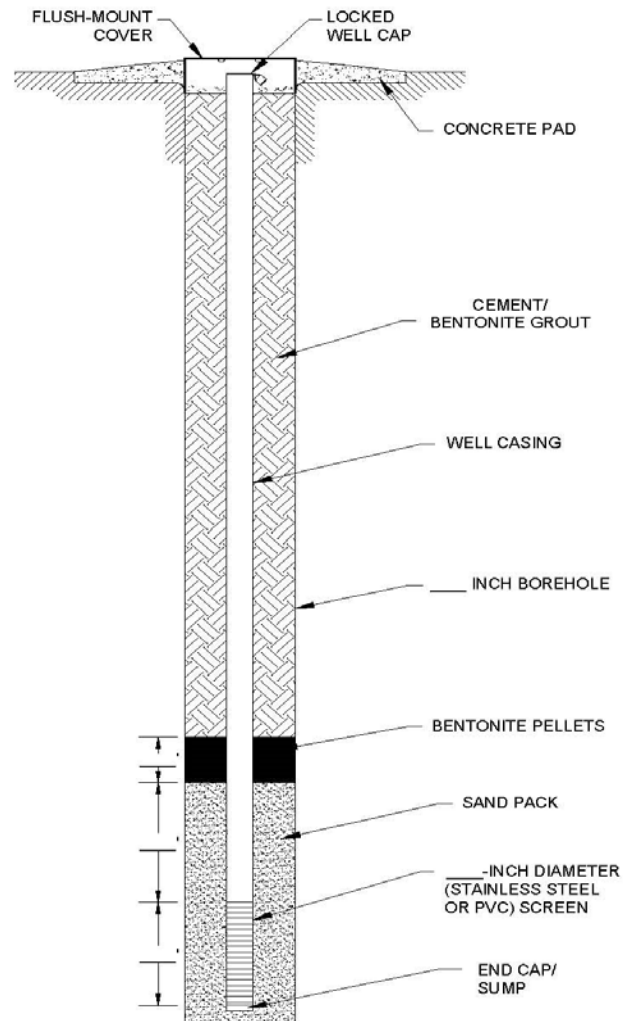
DRILL RIG _____

DRILLERS _____

INSTALLATION DATE _____

LOGGED BY _____

NOT TO SCALE



Details of Monitoring Well _____

Project _____

Project Location _____

Figure 3

Typical Construction Detail of Above-Grade Double-Cased Monitor Well

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(Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. _____

BORING DATA
 TOTAL DEPTH OF BOREHOLE _____
 HOLE DIAMETERS _____
 DRILLING METHOD(S) _____

SURFACE CASING
 DEPTH TO BEDROCK _____
 TOTAL DEPTH OF CASING _____
 CASING DIAMETER _____
 CASING MATERIAL _____

CONSTRUCTION DATA
 CASING LENGTH _____
 CASING DIAMETER _____
 CASING MATERIAL _____
 JOINT DESIGN _____
 SEAL _____
 FILTER PACK _____
 SCREEN SIZE _____
 SCREEN MATERIAL _____

A. CASING ELEVATION ABOVE GROUND _____
 B. DEPTH TO TOP OF CASING _____
 C. DEPTH OF TOP OF GROUT _____
 D. DEPTH TO TOP OF BENTONITE _____
 E. DEPTH TO TOP OF SAND _____
 F. DEPTH TO TOP OF SCREEN _____
 G. TOTAL WELL DEPTH _____
 H. WATER FIRST NOTICED _____
 I. DEPTH TO WATER AT COMPLETION _____

CLIENT _____
 DRILLING CONTRACTOR _____
 DRILL RIG _____
 DRILLERS _____
 INSTALLATION DATE _____
 LOGGED BY _____

NOT TO SCALE

Details of Monitoring Well _____
 Project _____
 Project Location _____

Figure 4

Design and Installation of Monitoring Wells in Aquifers

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Revision: 8

Date: February 2015

Typical Construction Detail of Flush-Mount Double-Cased Monitor Well (Not to Scale - Shown as an Example Only)

MONITOR WELL CONSTRUCTION DETAILS

WELL NO. _____

BORING DATA

TOTAL DEPTH OF BOREHOLE _____

HOLE DIAMETERS _____

DRILLING METHOD(S) _____

SURFACE CASING

DEPTH TO BEDROCK _____

TOTAL DEPTH OF CASING _____

CASING DIAMETER _____

CASING MATERIAL _____

CONSTRUCTION DATA

CASING LENGTH _____

CASING DIAMETER _____

CASING MATERIAL _____

JOINT DESIGN _____

SEAL _____

FILTER PACK _____

SCREEN SIZE _____

SCREEN MATERIAL _____

A. CASING ELEVATION
ABOVE GROUND _____

B. DEPTH TO TOP OF CASING _____

C. DEPTH OF TOP OF GROUT _____

D. DEPTH TO TOP OF BENTONITE _____

E. DEPTH TO TOP OF SAND _____

F. DEPTH TO TOP OF SCREEN _____

G. TOTAL WELL DEPTH _____

H. WATER FIRST NOTICED _____

I. DEPTH TO WATER AT
COMPLETION _____

CLIENT _____

DRILLING CONTRACTOR _____

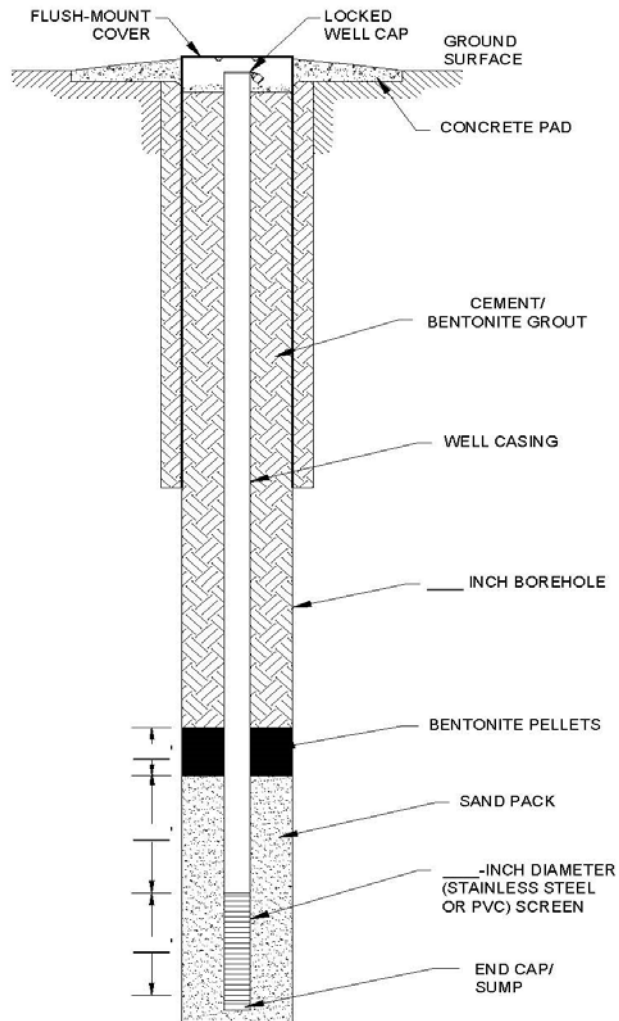
DRILL RIG _____

DRILLERS _____

INSTALLATION DATE _____

LOGGED BY _____

NOT TO SCALE



Details of Monitoring Well _____

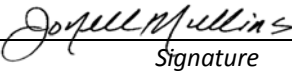
Project _____

Project Location _____

Field Equipment Decontamination at Nonradioactive Sites

SOP 4-5
Revision: 10
Date: February 2015

Approved:


Signature

Technical Review:

Robert R. Alexander

1.0 Objective

The objective of this technical standard operating procedure (SOP) is to describe the general procedures required for decontamination of field equipment at nonradioactive sites. This SOP serves as a general guide and is applicable at most sites; however, it shall be noted that site-specific conditions (i.e., type of contamination, type of media sampled), the governing agency (e.g., EPA, DOE, USACE), and site-specific work plans, sampling and analysis plans and/or quality assurance (QA) project plans may require modifications to the decontamination procedures provided in this SOP. Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants offsite.

2.0 Background

2.1 Definitions

Acid Rinse - A solution of 10 percent nitric or hydrochloric acid made from reagent grade acid and analyte-free water.

Analyte-Free Water - Tap water that has been treated so that the water contains no detectable heavy metals or other inorganic compounds. Analyte-free water shall be stored only in clean glass, stainless steel, or plastic containers that can be closed when not in use.

Clean - Free of contamination and when decontamination has been completed in accordance with this SOP.

Cross Contamination - The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or noncontaminated samples or areas.

Decontamination - The process of rinsing or otherwise cleaning the surfaces of sampling or other equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure to personnel.

Safety Data Sheets (SDS) - These documents discuss the proper storage and physical and toxicological characteristics of a particular substance used during decontamination. These documents, generally included in site health and safety plans, shall be kept on site at all times during field operations.

Organic-Free/Analyte-Free Water - Tap water that has been treated so that the water meets the analyte-free water criteria and contains no detectable organic compounds. Organic-free/analyte-free water shall be stored only in clean glass, Teflon™, or stainless steel containers that can be closed when not in use.

Potable Water - Tap water may be obtained from any municipal system. Chemical analysis of the water source may be required before it is used for decontamination purposes.

Sampling Equipment - Equipment that comes into direct contact with the sample media. Such equipment includes split spoon samplers, well casing and screens, and spatulas or bowls used to homogenize samples.

Soap - Low-sudsing, nonphosphate detergent such as Liquinox™.

Solvent Rinse - Pesticide grade, or better, isopropanol, acetone, or methanol.

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2.2 Associated Procedures

- SOP 1-1 – *Surface Water Sampling*
- SOP 1-3 – *Surface Soil Sampling*
- SOP 1-4 – *Subsurface Soil Sampling*
- SOP 1-5 – *Groundwater Sampling Using Bailers*
- SOP 1-7 – *Wipe Sampling*
- SOP 1-9 – *Tap Water Sampling*
- SOP 1-11 – *Sediment/Sludge Sampling*
- SOP 1-12 – *Low Flow (Low-Stress) Groundwater Sampling*
- SOP 1-13 – *Drum Sampling*
- SOP 1-14 – *Lagoon Sampling*
- SOP 1-15 – *Procedures for Determination of Screening-Level Elemental Concentrations in Soil and Sediment using Field Portable X-Ray Fluorescence Spectrometry*
- SOP 2-2 – *Guide to Handling Investigation-Derived Waste*
- SOP 3-1 – *Geoprobe® Sampling*

3.0 Responsibilities

The project manager or designee, generally the field team leader (FTL), ensures that field personnel are trained in the performance of this procedure and that decontamination is conducted in accordance with this SOP and site-specific work plans. The FTL may also be required to collect and document rinsate samples (also known as equipment blanks) to provide quantitative verification that these procedures have been correctly implemented.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance project plan (QAPP).

4.0 Required Equipment

- Stiff-bristle scrub brushes
- Plastic buckets and troughs
- Soap
- Nalgene or Teflon sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting, plastic bags, and/or aluminum foil to keep decontaminated equipment clean between uses
- Disposable wipes, rags, or paper towels
- Potable water*
- Analyte-free water
- Organic-free/analyte-free water
- Gloves, safety glasses, and other protective clothing as specified in the site-specific health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source (e.g., 10 percent and/or 1 percent nitric acid [HNO₃], acetone, methanol, isopropanol, hexane)
- Tools for equipment assembly and disassembly (as required)
- 55-gallon drums or tanks for temporary storage of decontamination water (as required)
- Pallets for drums or tanks holding decontamination water (as required)

* Potable water may be required to be tested for contaminants before use. Check field plan for requirements.

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5.0 Procedures

All reusable equipment (nondedicated) used to collect, handle, or measure samples shall be decontaminated before coming into contact with any sampled media or personnel using the equipment. Decontamination of equipment shall occur either at a central decontamination station or at portable decontamination stations set up at the sampling location, drill site, or monitoring well location. The centrally located decontamination station shall include an appropriately sized bermed and lined area on which equipment decontamination shall occur and shall be equipped with a collection system and storage vessels. In certain circumstances, berming is not required when small quantities of water are being generated and for some short duration field activities (i.e., pre-remedial sampling). Equipment shall be transported to and from the decontamination station in a manner to prevent cross contamination of equipment and/or area. For example, precautions taken may include enclosing augers in plastic wrap while being transported on a flatbed truck.

The decontamination area shall be constructed so that contaminated water is either collected directly into appropriate containers (5-gallon buckets or steel wash tubs) or within the berms of the decontamination area that then drains into a collection system. Water from the collection system shall be transferred into 55-gallon drums or portable tanks for temporary storage. Typically, decontamination water shall be staged until sampling results or waste characterization results are obtained and evaluated and the proper disposition of the waste is determined (SOP 2-2, *Guide to Handling Investigation-Derived Waste*). The exact procedure for decontamination waste disposal shall be discussed in the work plan. Also, solvent and acid rinse fluids may need to be segregated from other investigation-derived wastes.

All items that shall come into contact with potentially contaminated media shall be decontaminated before use and between sampling and/or drilling locations. If decontaminated items are not immediately used, they shall be covered either with clean plastic or aluminum foil depending on the size of the item. All decontamination procedures for the equipment being used are as follows:

General Guidelines

- Potable, analyte-free, and organic-free/analyte-free water shall be free of all contaminants of concern. Following the field QA sampling procedure described in the sampling plan, analytical data from the water source may be required.
- Sampling equipment that has come into contact with oil and grease shall be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or client requirements regarding solvent use shall be stated in the sampling plan.
- All solvents and acids shall be pesticide grade or better and traceable to a source. If provided, certificates of analyses should be placed in the project files. The corresponding lot numbers shall be recorded in the appropriate logbook.

Note: Solvents and acids are potentially hazardous materials and must be handled, stored, and transported accordingly. Solvents shall never be used in a closed building. See the site-specific health and safety plan and/or the chemical's MSDS for specific information regarding the safe use of the chemical.

- Decontaminated equipment shall be allowed to air dry before being used.
- Documentation of all equipment type, date, time, and method of decontamination along with associated field QA sampling shall be recorded in the appropriate logbook.
- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment shall be used as specified in the site-specific health and safety plan.

5.1 Heavy Equipment Decontamination

Heavy equipment includes drilling rigs, well development rigs, and backhoes. Follow these steps when decontaminating this equipment:

1. Establish a bermed decontamination area that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be used; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads shall be upwind of the area under investigation.

Field Equipment Decontamination at Nonradioactive Sites

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2. With the rig in place, spray areas (rear of rig or backhoe) exposed to contaminated media using a hot water high-pressure sprayer. Be sure to spray down all surfaces, including the undercarriage.
3. Use brushes, soap, and potable water to remove dirt whenever necessary.
4. Remove equipment from the decontamination pad and allow it to air dry before returning it to the work site.
5. After decontamination activities are completed, collect all contaminated wastewater, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the field plan. Liquids and solids must be drummed separately.

5.2 Downhole Equipment Decontamination

Downhole equipment includes hollow-stem augers, drill pipes, rods, stems, etc. Follow these steps when decontaminating this equipment:

1. Set up a centralized decontamination area, if possible. This area shall be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.
2. Set up a "clean" area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination pads shall be upwind of any areas under investigation.
3. Place the object to be cleaned on aluminum foil or plastic-covered wooden sawhorses or other supports. The objects to be cleaned shall be at least 2 feet above the ground to avoid splashback when decontaminating.
4. Using soap and potable water in the hot water high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.
5. If using soapy water, rinse the equipment using clean, potable water. If using hot water, the rinse step is not necessary if the hot water does not contain a detergent. If the hot water contains a detergent, this final clean water rinse is required.
6. Using a suitable sprayer, rinse the equipment thoroughly with analyte-free water.
7. Remove the equipment from the decontamination area and place in a clean area upwind to air dry.
8. After decontamination activities are completed, collect all contaminated wastewaters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

5.3 Sampling Equipment Decontamination

Follow these steps when decontaminating sampling equipment:

1. Set up a decontamination line on plastic sheeting. The decontamination line shall progress from "dirty" to "clean." A clean area shall be established upwind of the decontamination wash/rinse activities to dry the equipment. At a minimum, clean plastic sheeting must be used to cover the ground, table, or other surfaces that the decontaminated equipment is placed for drying.
2. Disassemble any items that may trap contaminants internally. Do not reassemble the items until decontamination and air drying are complete.

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3. Wash the items with potable water and soap using a stiff brush as necessary to remove particulate matter and surface films. The items may be steam cleaned using soap and hot water as an alternative to brushing. Note: Polyvinyl chloride or plastic items shall not be steam cleaned. Items that have come into contact with concentrated and/or oily contaminants may need to be rinsed with a solvent such as hexane and allowed to air dry prior to this washing step.
4. Thoroughly rinse the items with potable water.
5. The specific chemicals and/or fluids to be used in the decontamination process will be defined in the sampling plan. If sampling for metals, typically the potable water and soap wash is followed by a potable water rinse then an analyte-free water rinse; alternatively, an acid solution (e.g., 10 percent nitric acid) rinse followed by a rinse using analyte-free water may be specified in some instances. If sampling for organic compounds, thoroughly rinse the items with solvent (e.g., isopropanol) followed by a rinse using organic-free/analyte-free water. Again, the specific chemicals used in any acid rinse or solvent rinse phases shall be specified in the sampling plan. Any acid rinsate and solvent rinsate must each be containerized separately. Acids and solvents are potentially hazardous materials and care must be exercised when using these chemicals to prevent adverse health affects (e.g., skin burns, irritation to the eyes and respiratory system). Appropriate personal protective equipment must be worn when using these chemicals. The use of acids and solvents for decontamination should be carefully considered. These chemicals (including spent rinsate) must be managed and stored appropriately. Special measures such as proper labels, paperwork, notification, etc. may be required when transporting or shipping these chemicals.
6. Allow the items to air dry completely.
7. After drying, reassemble the parts as necessary and wrap the items in clean plastic wrap or in aluminum foil.
8. After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable personal protective equipment. Place the contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. Refer to site-specific plans for labeling and waste management requirements.

5.4 Pump Decontamination

Follow the manufacturer's recommendation for specified pump decontamination procedures. At a minimum, follow these steps when decontaminating pumps:

1. Set up the decontamination area and separate "clean" storage area using plastic sheeting to cover the ground, tables, and other surfaces. Set up four containers: the first container shall contain dilute (nonfoaming) soapy water, the second container shall contain potable water, the third container shall be empty to receive wastewater, and the fourth container shall contain analyte-free water.
2. The pump shall be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first container. Place the discharge outlet in the wastewater container above the level of the wastewater. Pump soapy water through the pump assembly until it discharges to the waste container. Scrub the outside of the pump and other wetted parts with a metal brush.
3. Move the pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.
4. Move the pump intake to the analyte-free water container. Pump the water through the pump assembly. Pump the volume of water through the pump specified in the field plan. Usually, three pump-and-line-assembly volumes shall be required.
5. Decontaminate the discharge outlet by hand, following the steps outlined in Section 5.3.

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6. Remove the decontaminated pump assembly to the clean area and allow it to air dry upwind of the decontamination area. Intake and outlet orifices shall be covered with aluminum foil to prevent the entry of airborne contaminants and particles.

5.5 Low Stress (Low Flow) Sampling Pump Decontamination

Sampling equipment used for Low Stress (Low Flow) Groundwater Sampling (SOP 1-12) must be decontaminated thoroughly each day before use (daily decontamination) and after each well is sampled (between-well decontamination). All non-disposable equipment, including the pump (support cable and electrical wires which are in contact with the sample) will be decontaminated as described below. Dedicated, in-place pumps and tubing must be thoroughly decontaminated using "daily decontamination" procedures prior to their initial use or installation.

5.5.1 Prior to Sampling Event Decontamination

Please Note: Steps 5 through 13 should only be performed once (for each pump that is to be used) before the commencement of a particular sampling event by a person qualified to disassemble pumps.

1. Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and thoroughly flush other equipment with potable water.
2. Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Liquinox™, for 5 minutes and thoroughly flush other equipment with fresh detergent solution. Use the detergent sparingly.
3. Rinse: Operate pump in a deep basin of potable water for 5 minutes and thoroughly flush other equipment with potable water for 5 minutes.
4. Analyte-Free Rinse: Operate pump in a deep basin of analyte-free water to pump out 1 to 2 gallons of this final rinse water.
5. Disassemble pump.
6. Wash pump parts (inlet screen, shaft suction interconnector, motor lead assembly, stator house): Place the disassembled parts of the pump into a deep basin containing 8 to 10 gallons of non-phosphate detergent solution. Scrub all pump parts with a test tube brush.
7. Rinse pump parts with potable water for five minutes.
8. Rinse the pump parts with demonstrated analyte-free water.
9. If sampling for metals, an acid rinse may be specified in the sampling plan; if so, place impeller assembly in a large glass beaker and rinse with 1% nitric acid (HNO₃).
10. Rinse impeller assembly with potable water for five minutes.
11. If sampling for organics, a solvent rinse may be specified; if so, place impeller assembly in a large glass bleaker and rinse with isopropanol or appropriate organic solvent specified in the site-specific plan.
12. Thoroughly rinse impeller assembly with demonstrated analyte-free water.
13. Reassemble pump.

5.5.2 Daily and Between-Well Decon

1. Pre-rinse: Operate pump in a deep basin containing 8 to 10 gallons of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.

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2. Wash: Operate pump in a deep basin containing 8 to 10 gallons of a non-phosphate detergent solution, such as Liquinox™, for 5 minutes and thoroughly flush other equipment with fresh detergent solution. Use the detergent sparingly.
3. Rinse: Operate pump in a deep basin of potable water for 5 minutes and thoroughly flush other equipment with potable water for five minutes.
4. Final Rinse: Operate pump in a deep basin of analyte-free water to pump out 1 to 2 gallons of this final rinse water.

5.6 Instrument Probe Decontamination

Instrument probes used for field measurements such as pH meters, conductivity meters, etc. shall be decontaminated between samples and after use with analyte-free, or better, water.

5.7 Waste Disposal

Refer to site-specific plans and SOP 2-2 for waste disposal requirements. The following are guidelines for disposing of wastes:

- All wash water, rinse water, and decontamination solutions that have come in contact with contaminated equipment are to be handled, packaged, labeled, marked, stored, and disposed of as investigation-derived waste.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.
- If large quantities of used decontamination solutions shall be generated, each type of waste shall be contained in separate containers.
- Unless otherwise required, plastic sheeting and disposable protective clothing may be treated as solid, nonhazardous waste.
- Waste liquids shall be sampled, analyzed for contaminants of concern in accordance with disposal regulations, and disposed of accordingly.

6.0 Restrictions/Limitations

Nitric acid and polar solvent rinses are necessary only when sampling for metals or organics, respectively. These steps shall not be used, unless required, because of the potential for acid burns and ignitability hazards.

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow. Check with your EPA region, state, and client for approved decontamination solvents.

7.0 References

American Society for Testing and Materials. 2015. *Standard Practice for Decontamination of Field Equipment at Waste Sites*, ASTM D5088-15. January 15.

Puls, R.W. and M.J. Barcelona. 1996. Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures, EPA/540/S-95/504.

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.1.

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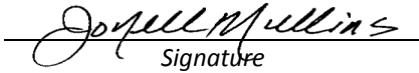
Borehole and Well Decommissioning

SOP 4-10

Revision: 2

Date: February 2015

Approved:



Signature

Technical Review:

David Schroeder

1.0 Objective

The purpose of this technical standard operating procedure (SOP) is to provide guidelines for the decommissioning of boreholes and wells. These guidelines help to produce consistency of approach in the planning and implementation of borehole and well decommissioning. Individual decommissioning procedures shall probably vary in some respects as a result of varying borehole or well construction materials and methods and regulatory framework.

2.0 Background**2.1 Definitions**

Note: The definitions provided are generalized. Definitions are often codified in state or local regulations and should be verified against the definitions presented in this SOP before commencement of work.

Decommissioning - The engineered closure of a well, borehole, or other subsurface monitoring device sealed with plugging materials. Decommissioning also includes the planning and documentation of all associated activities. Common synonyms for “decommissioning” include “destroying,” “plugging,” and “abandoning,” and the term used can vary between regulatory agencies.

Grout - Material consisting of bentonite, cement, or a cement-bentonite mixture.

Overdrilling - The process of drilling out a well casing and any material placed in the annular space.

Plugging Material - A material that has a hydraulic conductivity equal to or less than that of the geologic formation(s) to be sealed. Typical materials include portland cement and bentonite.

Tremie Pipe - A pipe or tube that is used to transport cement, bentonite, or other plugging materials from the ground surface to a specified depth in a borehole or well. The material may be allowed to flow freely or it may be injected under pressure.

Well Casing - Impervious durable pipe placed in a well to prevent the borehole walls from caving and to help seal off surface drainage or undesirable water, gas, or other fluids from entering the well.

2.2 Associated Procedures

- SOP 2-2, *Guide to Handling of Investigation-Derived Waste*
- SOP 3-5, *Lithologic Logging*
- SOP 4-1, *Field Logbook Content and Control*
- SOP 4-2, *Photographic Documentation of Field Activities*
- SOP 4-4, *Design and Installation of Monitoring Wells in Aquifers*
- SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

2.3 Discussion

This SOP is intended to cover the decommissioning of boreholes during environmental investigations and remediation efforts. It is intended to be a general guideline listing the types of materials and methods to be considered when a borehole or well is decommissioned. Materials are not specified in detail since it is likely there will be wide variability required to meet the needs of individual site conditions, specific clients, and regulatory requirements. If there is a conflict between this

SOP and procedures given by the federal, state, and/or local regulatory agencies involved in the decommissioning process, the materials and procedures given by the regulatory agencies shall take precedence.

Borehole and Well Decommissioning

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3.0 General Responsibilities

Field Team Leader - The field team leader (FTL) is responsible for ensuring that borehole and well decommissioning activities are conducted in accordance with this SOP and any site-specific work plans, scopes of work, quality assurance plan, and site health and safety plan.

Field Geologist - The field geologist is responsible for understanding and implementing this SOP during all field activities, as well as obtaining the appropriate permits, field logbooks, forms, and records necessary to complete the field activities. The field geologist collects and maintains data by providing oversight of the decommissioning procedures by the drilling subcontractor and completing the CDM Smith Borehole/Well Decommissioning Record (Figure 1). The field geologist coordinates and consults with the FTL on decisions relative to unexpected encounters during field activities and deviations from this SOP. The field geologist directs overall activities of drill and support subcontractors.

Drilling Subcontractor - The drilling subcontractor provides the necessary equipment and materials for borehole and monitoring well decommissioning. This generally includes a drill rig or service truck with grouting equipment and appropriate backfill materials such as portland cement, potable water, and bentonite powder and/or chips. The drilling subcontractor is responsible for submitting forms and records required by law or regulations to the applicable state and/or local regulatory agency and as required in the subcontractor statement of work.

Note: Responsibilities may vary from site to site. Therefore, all field team member responsibilities shall be defined in the field plan or site-/project-specific quality assurance plan.

4.0 Required Equipment and Materials

4.1 Required Field Equipment and Supplies

- Water level indicator
- Personal protective equipment (PPE)
- Tape measure (weighted tip)
- Camera
- Health and safety equipment
- Explosimeter, OVA (FID) or OVM per health and safety plan
- Bound field logbook
- CDM Smith Borehole/Well Abandonment Form
- Backfill materials (e.g., portland cement, potable water, and bentonite powder and/or chips)
- Global positioning system (GPS) equipment (if required)
- Downhole video equipment (if required)

4.2 Required Construction Materials

Note: The materials that are used in the decommissioning of a borehole or well and that come in contact with groundwater shall not measurably alter the chemical quality of the groundwater source.

Water - Water, which may be used in the well decommissioning process, shall be obtained from a source that does not contain constituents that could compromise groundwater quality. A certificate of analysis should be provided with the water, potable water from an approved source should be used, or a sample of the water should be analyzed and documented as contaminant-free.

Plugging Materials - The materials used to plug the borehole or well casing may be prepared as a slurry or used unmixed in a dry pellet form, depending on the application. Plugging materials shall be selected for compatibility with local geologic, hydrogeologic, climatic, and human-induced conditions in the subsurface.

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Grout - The grout used for decommissioning boreholes or wells shall be a liquid slurry consisting of water, bentonite of Volclay or equivalent quality, and/or portland cement. Bentonite-based grout is typically used when a more flexible grout is desired (i.e., freeze-thaw). Cement-based grout provides a more rigid plugging material. A typical bentonite slurry mixture is a minimum 20 percent solids slurry by weight. Cement-bentonite grout is typically 6 to 7 gallons of water per 94 pound bag of Type I portland cement and 2.7 percent bentonite powder.

Bentonite - Bentonite shall be powdered, chipped, or pelletized sodium montmorillonite furnished in sacks or buckets from a commercial source and free of impurities that adversely impact water quality in the subsurface. Pellets or chips are typically used for plugging shallow boreholes and powdered bentonite is used for mixing in grout.

Cement - Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement shall generally be portland Type I, Type II, or Type I/II as specified in ASTM C 150. Quicksetting cements containing additives are not allowable for use in decommissioning. Additives may leach from the cement and influence the chemistry of the groundwater.

Tremie Pipe - A tremie pipe is used to inject grout-based plugging materials. Tremie pipes are typically constructed of PVC or galvanized steel. Associated equipment may include a trough or mixing box and "mud pump" to place the material.

5.0 Procedures

The actual methods of decommissioning boreholes or wells at a site vary depending on site conditions and the construction materials and methods used during the original installation. The method to be used at a site shall be stated in the site-specific plans. Deviations from the methods prescribed in these plans shall be approved by the FTL or designee.

A description of plugging materials, volume calculations, and/or overdrilling observations needs to be recorded on the CDM Smith Borehole/Well Decommissioning Form (Figure 1) or in a logbook (SOP 4-1).

5.1 Pre-Decommissioning Preparation

Well construction records (if available) should be obtained before field mobilization to understand the construction of the wells requiring decommissioning. Records are used to verify depths and construction materials within the well before start of decommissioning activities and as decommissioning activities are completed. The records may also be required by state and/or local regulatory agencies as part of the decommissioning permitting process.

State or local regulations may require either pre- and post-notification or a permit during borehole or well decommissioning activities; each borehole or well at a site may require individual notification and/or permits. Before initiating field work, state and local regulations shall be researched and the notification and/or permitting procedures provided by the regulatory agencies shall be followed. Some state and local regulations require the driller or drilling company licensed in the jurisdiction to submit the required decommissioning paperwork and obtain the permits from the regulatory agencies. The drilling subcontractor statement of work should clearly designate whether the subcontractor or CDM Smith is responsible for submitting decommissioning paperwork to the regulatory agencies in accordance with the regulations.

5.2 Borehole or Well Inspection

Before decommissioning, each borehole or well shall be inspected for obstructions (including but not limited to pumps, sampling equipment, debris, and other undesirable materials that might interfere with decommissioning) and remove them. Disposal of materials removed from boreholes or wells shall be in accordance with the site-specific plans and SOP 2-2.

Total depth of the borehole or well should be verified using a weighted tape, compared to any records obtained from original borehole or well installation, and recorded on the CDM Smith Borehole/Well Decommissioning Form (Figure 1) or in a logbook (SOP 4-1). The preexisting condition of the borehole or well prior to decommissioning shall be recorded in the logbook and photographed in accordance with SOP 4-2. Some state or local regulatory agencies may have additional pre-decommissioning requirements such as field location of the borehole or well using GPS equipment or downhole video inspection of the well before decommissioning. This information should also be recorded on the borehole/well decommissioning form and in the logbook.

Borehole and Well Decommissioning

SOP 4-10

Revision: 2

Date: February 2015

5.3 Well Overdrilling (Not Applicable to Borehole Decommissioning)

The requirement for overdrilling wells during decommissioning shall vary to meet the needs of individual site conditions, specific clients, and regulatory requirements. Some state and local regulatory agencies require all well construction materials to be removed from the borehole using an overdrilling method before the remaining borehole can be plugged. It is generally preferable to pull the well casing from the subsurface by overdrilling the annular space of the well and remove the casing in whole sections. Site-specific conditions and well construction materials may preclude removal of all casing materials using an overdrilling/pulling method.

The actual methods for overdrilling wells at a site shall vary depending on site conditions and the construction materials and methods used during the original well installation. The method to be used at a site shall be stated in the site-specific plans. Deviations from the methods prescribed in these plans shall be approved by the FTL or designee. Typical overdrilling methods include air rotary, mud/fluid rotary, roto sonic, and hollow-stem auger. Drilling with mud or water is least desirable, but the driller shall have the capability to use this method if well conditions warrant it. The wells shall be overdrilled to the well depth specified in the site-specific plans but may vary based on actual well construction depth (determined in the field) required to remove well construction materials. Drillers must prevent grease, oil, and other fluids from the drill rig from coming in contact with the ground around the area of well installation. Disposal of materials removed from wells shall be in accordance with the site-specific plans and SOP 2-2.

A description of overdrilling observations needs to be recorded on the CDM Smith Borehole/Well Decommissioning Form (Figure 1) or in a logbook (SOP 4-1). Unusual conditions or materials observed during overdrilling shall be photographed in accordance with SOP 4-2.

5.4 Borehole or Well Plugging

The following processes apply to both boreholes and wells. It should be noted that plugging processes shall vary with the total depth of the borehole or well and/or the type of well construction. Generally, plugging using bentonite pellets or chips is only allowable for shallow boreholes less than 10 feet below ground surface (bgs). Chips should not be used for plugging small-diameter boreholes because of bridging concerns due to their angular shape. The method to be used at a site for a particular borehole or well shall be stated in the site-specific plans. Deviations from the methods prescribed in these plans shall be approved by the FTL or designee.

The CDM Smith field geologist shall calculate the amount of plugging material needed to fill the borehole or well casing to complete decommissioning. These calculations should be completed in the field after borehole or well depths and dimensions have been inspected and verified. The volume and depth of plugging materials used for borehole or well decommissioning shall be documented on the CDM Smith Borehole/Well Decommissioning Form (Figure 1) or in a logbook (SOP 4-1).

5.4.1 Plugging Using Bentonite Pellets or Chips

Boreholes completed to a depth less than 10 feet may be backfilled with bentonite pellets or chips and hydrated until the pellets or chips come within 6 inches of the surface. The chips shall be installed by gravity feed down the center of the borehole. The depth of the pellets or chips shall be tracked using a weighted tape to ensure there is no bridging. The chips shall be hydrated at 2-foot intervals using sufficient quantities of clean water to allow for adequate saturation and expansion of the bentonite.

5.4.2 Plugging Using Grout

Boreholes greater than 10 feet in depth and wells shall be plugged using grouting methods. A sufficient volume of grout shall be premixed onsite, according to procedure stipulated by the manufacturer, to compensate for unexpected losses to the formation. This process shall be checked against the calculated volume of the borehole or well casing to be decommissioned to ensure that bridging does not occur during emplacement. The use of alternate grout materials, including grout containing portland cement, may be necessary to control zones of high grout loss. The mixing (and placing) of grout shall be performed with recorded weights and volumes of materials, according to procedures stipulated by the manufacturer. Lumpy grout shall not be used in an effort to prevent bridging within the tremie and the well. Bentonite-based grout of Volclay or equivalent type shall be mixed to the manufacturer's specifications and then pumped into place using minimum pump pressure. All additives to grouts shall be evaluated for their effects on the subsurface.

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Depending upon the borehole or well depth and/or construction, plugging may be accomplished using a pressure grouting technique or by gravity feed through a tremie pipe. With either method, grout is introduced in one continuous operation until grout flows out at the ground surface without evidence of drill cuttings or fluid. The grout shall be injected under pressure using a tremie pipe when possible to reduce the possibility of leaving voids in the annular seal and to displace any liquids or drill cuttings that may remain in the borehole or well casing. The tremie pipe shall be kept full of grout from start to finish with the discharge end of the pipe completely submerged as it is slowly and continuously lifted. Pump pressure shall be kept to a minimum.

Approximately 5 to 10 feet of tremie pipe shall remain submerged during grout emplacement. If possible, steel tape soundings shall be made to ensure the level of the tremie material is in agreement with the calculated volume and that the desired placement of plugging materials is achieved. A staged grouting procedure may be considered if there is significant grout loss into the formation because of the weight exerted by the full column of grout as it sets. If used for borehole or well drilling, temporary casing or hollow-stem augers shall be removed in increments (immediately following each lift of grout installation) well in advance of the time when the grout begins to set. The initial grout mixture must be allowed to cure for approximately 24 hours, then checked and refilled to within 6 inches of the surface.

5.5 Surface Restoration

Surface completion materials for wells (such as protective casing, bumper posts, and concrete pads) should be removed to the extent possible. If overdrilling is required, removal of surface completion materials shall be performed before the overdrilling operation. Well and surface casings (if left in the subsurface) should be removed to an approximate depth of 2 feet bgs before surface restoration. Disposal of materials removed from wells shall be in accordance with the site-specific plans and SOP 2-2.

The upper 6 inches of the borehole or well that has been decommissioned shall be completed with similar surface material (i.e., sod, asphalt, concrete) as the surrounding area. In the case of soil boreholes completed in an area absent of surface material, the overlying soil shall be used to backfill the remaining 6 inches of the borehole until flush with the surrounding surface.

5.6 Post Operation Procedures**5.6.1 Field Procedures**

At the conclusion of the borehole or well decommissioning activities, all equipment coming in contact with the subsurface must be decontaminated (according to SOP 4-5) before moving the equipment to a different work location. All water used in the decontamination of equipment shall be contained in an appropriate container, if required in the site-specific plans. Disposal of decontamination water shall be in accordance with the site-specific plans and SOP 2-2.

5.6.2 Documentation

The CDM Smith Borehole/Well Decommissioning Form (Figure 1) shall be completed by the CDM Smith field geologist or designee at the conclusion of the field activity. Any post-notification or decommissioning paperwork to be submitted to regulatory agencies shall be completed by the drilling subcontractor or CDM Smith designee as required by regulations.

Copies of all field notes, the daily logs, and the CDM Smith Borehole/Well Decommissioning Forms shall be given to the FTL. These records shall be maintained in the project and document control files. At a minimum, all materials used for decommissioning shall be documented by entering identifying numbers (lot numbers, manufacturer's identification, etc.) in the field logbook and on the CDM Smith Borehole/Well Decommissioning Form. Samples of decommissioning materials (including grout, sand, etc.) may be archived if specified in the site-specific plans.

6.0 Restrictions/Limitations

Check with the federal, state, and local agencies for specific decommissioning procedures. If no specific decommissioning procedures are identified, the decommissioning materials and methods provided in this procedure shall be followed.

Borehole and Well Decommissioning

SOP 4-10

Revision: 2

Date: February 2015

7.0 References

American Society for Testing and Materials (ASTM). 1999 (Reapproved 2012)e1. *Standard Guide for Decommissioning Ground Water Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities*. Standard Method D 5299-99.

U. S. Army Corps of Engineers (USACE). Nov. 1, 1998. *Engineering Manual (EM) 1110-1-4000. Monitoring Well Design, Installation, and Documentation at Hazardous, Toxic, and Radioactive Waste Sites*.

Example
**CDM
Smith** Borehole/Well Decommissioning Record

Borehole/Well Identification No. _____

Facility or Project Area:	Site:	Job No:
----------------------------------	--------------	----------------

Recorded By:	Date:	Checked By:
---------------------	--------------	--------------------

Borehole/Well Decommissioning Permit No. (if applicable): _____

Regulatory/Permitting Agency: _____ Contact: _____ Phone No.: _____

Original Borehole/Well Construction Records Available and Reviewed? (Attach) Yes ____ No ____

Condition of Borehole/Well at Ground Surface before Decommissioning: _____

Maximum Depth Measured in Borehole/Well: _____ Datum: _____

Original Borehole/Well Bore Depth from Records (if available): _____

Downhole Obstruction Indicated? Yes ____ No ____

If yes, describe the method(s) used to assess the nature of the obstruction and/or methods to remove it: _____

Depth (feet) to Water before Borehole/Well Decommissioning: _____ Datum: _____

Date of water level measurement: _____

Any Indications of Borehole/Well Contamination? Yes ____ No ____

If yes, describe field evidence suggesting borehole/well contamination: _____

Plugging/Sealing Material Used for Decommissioning and Corresponding Depth Intervals:

Plugging Material	From	To	Qty. Sacks Cement	Qty. Sacks Sand	Qty. Sacks Bentonite	Qty. Sacks Aggregate	Qty. Gal. Water
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____	_____

Manufacturer/Supplier Information for Plugging Materials:

Surface Restoration Materials (describe): _____ From: _____ To: _____
_____Comments: _____

Appendix B

Appendix B

Field Forms

ANSETS Data Requirement

Date: _____

Sampling Start Date: _____

Sampling End Date: _____

Project Numbers			
Project Number:	Regional Account Number:	DAS Number:	Assoc. CLP Case No:
Site Information			
Site Name:		City:	State:
CERCLIS ID:	Operable Unit:	Action:	Funding Lead:
Responsible EPA Project Individual:		Sampling Organization:	

Analytical Services Information	
If field analytical services are used during this project write Afield analysis@ in the Laboratory Name Column. If fixed laboratory is used write the name of the laboratory in the Laboratory Name Column. Please specify in this box all field analytical techniques used.	COST:

Laboratory Name (include location if multiple lab locations)	No. Samples	Matrix	Analysis	Requested Turnaround (Days)
Completed by:		Organization:		Date:

Eleven Chain of Custody Rules to Remember



COCs MUST REFLECT:

1. Case Number*
2. Case Open or Closed
3. Analysis Required (use standard codes)
4. TAT Requirement
5. Modified Analysis Number (if applicable)
6. Sample Date and Time (matching label)
7. Destination Laboratory
8. Lab Address (verify subcontract lab and lower tier address)
9. Sampler's Signature
10. Relinquisher's Signature
11. CLP Sample Numbers

Resources:

CLP Guidance for Field Samplers. January 2011

*A case # is used for CLP Lab Assignments

Only DESA gets the Regional COC

Items 1, 3, 4, 5, 7 & 8 must match Lab Assignment Form

Questions contact -

Scott Kirchner/ Jeniffer Oxford/ Vanessa Macwan/Troy Gallagher

Please use this FedEx airbill to return **all coolers** sent to your lab under this case number. It should be sent FedEx Express Saver (Third Business day) and addressed:

CDM Federal Warehouse
115 Newfield Ave.
Edison, NJ 08837
Attn: Equipment Return

Thanks,

CDM Federal Programs Corporation

Please use this FedEx airbill to return **all coolers** sent to your lab under this case number. It should be sent FedEx Express Saver (Third Business day) and addressed:

CDM Federal Warehouse
115 Newfield Ave.
Edison, NJ 08837
Attn: Equipment Return

Thanks,

CDM Federal Programs Corporation

DAILY SIGN-IN SHEET
PIERSON'S CREEK SUPERFUND SITE, OU1

Date	Print Name	Signature	Affiliation	Time On-Site	Time Off-Site

DRUM TRACKING LOG

SITE NAME: PIERSON'S CREEK SUPERFUND SITE, OU1

Drum #	Boring/MW#	Date Drilled/ Sampled	Related Sample #	Description of Drum Contents	Signature

EQUIPMENT LIST
PIERSON'S CREEK SUPERFUND SITE, OU1

Item	Unit*	Quantity
Acetone - Pesticide Grade (4 liter bottle) 4/case		
Acid, hydrochloric - Optima		
Acid, nitric - Optima		
Acid, nitric - 2.5L 10% Solution		
Bags, garbage (200/case)		
Bags, ZipLock - large 10x12 (1000/case)		
Bags, ZipLock - small 8x8 (1000/case)		
Book, log / Rite in the Rain Environmental No. 550		
Boot Covers (yellow) - XXL		
Bottle - En Core Sampler		
En Core - Standard T-Handle		
Bottle, 60 ml welded septa clear jars (24/case)		
Bottle, amber, 1-liter (12/case)		
Bottle, poly 100 ml (48/case - temp. blanks) - not certified clean		
Bottle, poly 1-liter (12/case)		
Bottle, short clear wide mouth 250ml (24/case)		
Bottle, glass vial, 40-ml (72/case)		
Bottles, Squirt (decon - nitric)		
Bottles, Spray (decon - acetone)		
Calibration Gas (Isobutylene)		
Calibration Gas, Pentane 50% Span R-SGPEN 17Ltr		
Camera, digital		
Can, gas (OSHA)		
Caution Tape		
Custody Seals (100/pack)		
Drums, Waste PPE/Purge Water		
Ear Plugs		
Eye Saline Solution for large Eye Wash Station		
Eyeglasses, safety		
Eyewash (Portable)		
Film Developing		
Flagging Tape		
Foil, aluminum (12"x1000') standard weight		
Gloves, Cotton Liners (12/pack)		
Gloves, Nitrile 12 inch size 10 (12/bag, 144 per case)		
Gloves, Nitrile disposable		
Gloves, Surgical (latex) (100 per box, 2000 per case)		
Gloves, Work (cotton)		
Ice		
Knife, utility		

EQUIPMENT LIST
PIERSON'S CREEK SUPERFUND SITE, OU1

Item	Unit*	Quantity
Liquidnox (1 gallon bottle)		
Markal Paintstik B		
Paper, PH Double-Roll Dispenser (1-14)		
Pens, ball point		
Pens, Sharpies		
Pipet - Standard Bulb Pipet (500/case)		
Plain Vinyl Flags		
Poly Sheeting (12'x100' - 4 mil.)		
Rope, poly (for pumps) 1/4"		
Sodium Hydroxide		
Stakes, Wooden, 3' bundle of 50		
Stay Ties (100 ct)		
Tape, clear		
Tape, duct		
Tape, electrical		
Tape, strap (48 rolls/case)		
Tape, Measuring (200') Fiberglass Keson Open Reel		
Tape, Measuring (300') Fiberglass Keson Open Reel		
Tarp, plastic		
Teflon Lined Tubing		
Towels, paper (30 ct)		
Tubes, Draeger (10/carton)		
Tubing, Polyethylene		
Tyvek (Standard Coveralls w/Hood, Elastic Wrists & Ankles - XX Large, 25/case)		
Water, Deionized (5 gal)		
Water, Reagent Grade 4 liter bottle (4/case)		
Wipes, respirator (100/carton)		
Boots, hipwaders		
Boots, Latex		
Boots, Slush		
Bowls, Stainless Steel		
Box Clipboard		
Bucket, w/cover (5 gallon)		
Bulletin Board		
Cans, water (5 gallon)		
Coolers - Large		
Coolers - Medium		
Coolers - Small		
Cutters, bolt		
Decon Tub 14 Gal Rubbermaid		

EQUIPMENT LIST
PIERSON'S CREEK SUPERFUND SITE, OU1

Item	Unit*	Quantity
Dry - Erase board		
Eyewash Station (15 min)		
Fire extinguisher		
First Aid Kit		
Folding Rules, Lufkin Red End Engineer's		
Gauge, Rain		
Inverter 550		
Munsell Color Chart		
Portable UV light & replacement light tube		
Refrigerator		
Scale, Engineer		
Scrub brush, long handle		
Scrub brush, short handle		
Scrub brush - toilet		
Scrub brush - bottle		
Scupula Spatulas		
Spoons, Stainless Steel		
Stainless Steel Sprayer		
Plastic Sprayer		
Suit, Rain		
Tool Box w/ tools		
Traffic Cones		
Trowel, Stainless Steel		
Heavy Chain - 6 feet with large pad lock		
Folding Chairs		
Small Screw Driver - used to calibrate the LEL/O2 Meter		

RAC II
PIERSON'S CREEK SUPERFUND SITE, OU1
FIELD CHANGE NOTIFICATION (FCN) FORM

REQUEST NO: _____

DATE: _____

FCN TITLE: _____

DESCRIPTION: _____

REASON FOR DEVIATION: _____

RECOMMENDED/MODIFICATION: _____

INCLUDE IMPACT ON DATA QUALITY OBJECTIVES: _____

Signatures: _____
Field Team Leader (FTL)

Date

CDM Smith Site Manager (SM)

Date

Distribution: EPA Remedial Project Manager
CDM Smith SM
Regional Quality Assurance Specialist
Field Team
Project File

**GENERAL EQUIPMENT CALIBRATION LOG
PIERSON'S CREEK SUPERFUND SITE. OU1**

Instrument (make/model/serial #): _____ Manufacturer: _____ Rental Company: _____

Upon receipt, all parts are included and this instrument is in working order: _____
(signature/date)

Calibration Date	Initial Setting	Standard/ Gas Used (Concentration)	Lot Control No. Expiration Date	Adjustments Made	Final Reading	Comments Pass/Fail	Signature

**PIERSON'S CREEK SUPERFUND SITE, OU1
LOW FLOW GROUNDWATER SAMPLING PURGE RECORD**

DATE: _____ **WELL #:** _____

SAMPLERS: _____ **DEPTH OF PUMP INTAKE:** _____ **ft TIC or ft BGS (circle one)**

WEATHER CONDITIONS: _____ **SCREENED/OPEN BOREHOLE INTERVAL:** _____ **ft TIC or ft BGS (circle one)**

SAMPLE ID: _____ **SAMPLE TIME:** _____ **SAMPLE FLOW RATE:** _____ **ml/minute**

CLP ID: _____

Instrument Type/Model: _____ Complete and/or Circle at right					YSI Model # _____ / Horiba U-22 (circle one) Other (specify) _____					Instrument:
CURRENT TIME	VOLUME PURGED	DEPTH TO WATER	FLOW RATE	DRAWDOWN (± 0.3 FT)	pH (± 0.1 SU)	SPECIFIC CONDUCTIVITY (± 3%)	DISSOLVED OXYGEN (± 10%)	TEMP. (± 10%)	REDOX POTENTIAL (± 10 mV)	TURBIDITY (± 10%)
24-Hour	gallons / liters (circle	ft TIC / ft BGS (circle one)	Units:	ft TIC / ft BGS	SU	S/cm, mS/cm°/ or µS/cm (circle one)	mg/L (not %)	Units: °C	mV	NTUs

Drawdown is not to exceed 0.3 feet. Flow rate should not exceed 500 ml/min during purging or 250 ml/min during sampling. Readings should be taken every three to five minutes. The well is considered stabilized and ready for sampling when the indicator parameters have stabilized for three consecutive readings by the measurements indicated in parenthesis.

Typical values: DO = 0.3 - 10 mg/L Redox Potential = -100 - +600 mV Turbidity = 0 - >500 NTUs
 Spec. Conductivity (µS/cm) = 0.01 - 5,000; up to 10,000 in industrial, ~55,000 in high salt content water. Note: 1,000 µS/cm = 1 mS/cm

TIC = Top of Inner Casing BGS = Below Ground Surface

Instrument Calibration Log
RAE Systems
MultiRAE + (4 gas + PID)
PIERSON'S CREEK SUPERFUND SITE, OU1

Calibration Completed By	Date	Rental Company	Rental Company Number	Instrument Serial Number	Time Instrument On ¹	Warm Up 5 to 10 Minutes ²

Calibration Gas	Manufacturer	Lot No./Expiration Date	Concentration(s)
			CO: H ₂ S: LEL: O ₂ :
			Isobutylene:

Fresh Air Calibration	Carbon Monoxide (CO) Reading	VOC ³ Reading (zero)	H ₂ S Reading (zero)	LEL Reading (zero)	Oxygen (O ₂)
Expected Reading ⁴	Zero	Zero	Zero	Zero	20.9%
Actual Reading					

Multiple Sensor Calibration	CO Reading	H ₂ S Reading	LEL Reading	O ₂ Reading	VOC Sensor Calibration	VOC Reading
Expected Reading ⁵					Expected Reading	
Actual Reading					Actual Reading	

Instrument OK? YES (Calibration Completed) NO (Problem with instrument, detail in comments) _____

Calibration Check ⁶	Completed (Circle one): YES NO	
Time:	Date:	Calibration Completed By:
Calibration Gas	Same as Above (Circle one)? YES NO	(IF NO COMPLETE INFORMATION BELOW)
	Manufacturer	Lot No./Expiration Date Concentration(s)
		CO: H ₂ S: LEL: O ₂ :
		Isobutylene:

¹ Note time instrument is turned on for initial warm up

² While instrument is warming up, make sure inlet tubing is connected to a hydrophobic filter and fill one Tedlar bag with isobutylene and one with four gas mix

³ VOC – volatile organic compounds, H₂S – hydrogen sulfide, LEL – lower explosive limit

⁴ Instruments should read zero after fresh air calibration is complete, write down actual readings below headings

⁵ Write concentration from calibration gas on this line

⁶ Complete at the end of the day

Instrument Calibration Log
RAE Systems
MultiRAE + (4 gas + PID)
PIERSON'S CREEK SUPERFUND SITE, OU1

Calibration Check Readings:				
CO:	H ₂ S:	LEL:	O ₂ :	VOC:

Comments/Corrective Action: _____

NON-CLP SAMPLE TRANSFER INFORMATION

Site Name:_____

Sampling Contact:_____

Site Phone No.:_____

Send Results To: Scott Kirchner, CDM Federal,
 110 Fieldcrest Ave
 Edison, NJ 08837 (732) 590-4677

Send Invoice To:_____

Cooler Return Information:_____

PHOTOLOG

SITE NAME: PIERSON'S CREEK SUPERFUND SITE, OU1

CAMERA # _____

Photograph #	Description	Date/Time	Photographer

SAMPLE TRACKING LOG

LDL VOC LAB: _____ INORGANIC CLP LAB: _____

CLP CASE NO: _____ ORGANIC CLP LAB: _____ SUBCONTRACT LAB: _____

SAMPLE ID	SAMPLE DATE	SAMPLE TIME	MATRIX	DEPTH (feet)	LDL VOC CLP NO.	ORGANIC CLP NO.	INORGANIC CLP NO.	SUBCONTRACT ANALYSIS	QA/QC

ANALYSIS SUMMARY: _____

Facility Information

Well Locational Information

Well Construction Details

EPA Region 2 Superfund Well Assessment Checklist

Well Headspace Readings

PID/FID Reading taken inside top of casing (if applicable): _____ ppm

Multi-gas/CGI meter Readings taken (if applicable):

LEL: _____ % LEL
 O₂: _____ 40% Vol.
 CO: _____ ppm
 H₂S: _____ ppm

Do readings indicate unsafe conditions exist? Yes No

Well Condition

Is the concrete pad in good condition?	Yes	No
Is the well surface casing in good condition?	Yes	No
Is the surface casing vertical?	Yes	No
Is there an internal well seal?	Yes	No
Has there been physical damage to the well?	Yes	No
Does sounding depth match completed depth?	Yes	No
Is measuring point marked?	Yes	No
Is the well clearly labeled?	Yes	No
Flush mount - Is it secure from runoff?	Yes	No

Other Comments _____

Recommendations

Well needs to be redeveloped	Yes	No
Well needs to be re-surveyed.	Yes	No
Well needs to be repaired.	Yes	No
Well needs to be replaced.	Yes	No
Well needs to be properly abandoned.	Yes	No
No action necessary.	Yes	No

Comments

Inspected by:	
Date of Inspection:	
Reviewed by:	(Print)
	(Sign)

Appendix C

Appendix C

Manuals for Mercury Vapor Analyzer (MVA), Sorbent Tube Sampling, and Long-Term Water Level Monitoring Transducers

Level TROLL[®] 400, 500, 700, 700H Instruments



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The presence of the Waste Electrical and Electronic Equipment (WEEE) marking on the product indicates that the device is not to be disposed via the municipal waste collection system of any member state of the European Union.

For products under the requirement of WEEE directive, please contact your distributor or local In-Situ office for the proper decontamination information and take back program, which will facilitate the proper collection, treatment, recovery, recycling, and safe disposal of the device.

0052212 | 2018-05-07

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Introduction

The Level TROLL Instrument is a compact, modular system for measuring level and temperature in natural groundwater, surface water, industrial waters, and other installations.

Scope

This document is intended to describe the characteristics, operation, calibration, and maintenance of the instrument. Communication registers and SDI-12 programming information can be found in the Modbus and SDI-12 Reference Guides on the In-Situ website.

Serial Number Location

The serial number is engraved on the instrument housing. It is also programmed into the instrument and is displayed when the instrument is connected to a computer running Win-Situ Software.

Certification

See the Declarations of conformity at end of this manual.

Unpacking and Inspection

Your instrument was carefully inspected before shipping. Check for any physical damage sustained during shipment. Notify In-Situ and file a claim with the carriers involved if there is any shipping damage. Accessories may be shipped separately and should also be inspected for physical damage and the fulfillment of your order.



Please save packing materials for future storage and shipping. The shipping boxes have been performance-tested and provide protection for the instrument and its accessories.

Warranty

See the product specification tables for warranty information.

Contact Information

Mailing and Shipping Address:

In-Situ
221 East Lincoln Avenue
Fort Collins, CO 80524
U.S.A.

Phone: 970-498-1500 (international & domestic)

Fax: 970-498-1598

Internet: www.in-situ.com

Support: 800-446-7488 (U.S.A. & Canada)

Product Specifications

Level TROLL 400 Instrument

General	Level TROLL 400
Temperature ranges ¹	Operational: -20-80° C (-4-176° F) Storage: -40-80° C (-40-176° F) Calibrated: -5-50° C (23-122° F)
Diameter	1.83 cm (0.72 in.)
Length	21.6 cm (8.5 in.)
Weight	124 g (0.27 lb)
Materials	Titanium body; Delrin nose cone
Output options	Modbus/RS485, SDI-12, 4-20 mA
Battery type & life ²	3.6 V lithium; 10 years or 2M readings
External power	8-36 VDC
Memory	2.0 MB
Data records ³	130,000
Data logs	50
Log types	Linear, Fast Linear, and Event
Fastest logging rate & Modbus rate	2 per second
Fastest SDI-12 & 4-20 mA output rate	1 per second
Real-time clock	Accurate to 1 second/24-hr period
Sensor Type/Material	Piezoresistive; titanium
Calibrated Range (Usable Depth)	<i>Absolute (non-vented)</i> 30 psia (11 m, 35 ft) 100 psia (60 m, 197 ft) 300 psia (200 m, 658 ft) 500 psia (341 m, 1120 ft)
Burst pressure	Max. 2x range; burst > 3x range
Accuracy (FS) ⁴	±0.05%
Long-term stability ⁵	< 0.1% FS
Resolution	±0.005% FS or better
Units of measure	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH ₂ O, inH ₂ O Level: in, ft, mm, cm, m
Temperature Sensor	
Accuracy & resolution	±0.1° C; 0.01° C or better
Units of measure	Celsius or Fahrenheit
Warranty	3 years Extended warranties are available for all instruments—call for details

Footnotes	¹ Temperature range for non-freezing liquids
	² Typical battery life when used within the factory-calibrated temperature range
	³ 1 data record = date/time plus 2 parameters logged (no wrapping) from device within the factory-calibrated temperature range
	⁴ Across factory-calibrated pressure and temperature ranges. Defined as greater than 98% of all readings fall within spec across full temperature and pressure
	⁵ Includes linearity and hysteresis over one year Specifications are subject to change without notice. Delrin is a registered trademark of E.I. du Pont de Nemours and Company.

Level TROLL 500 Instrument

General	Level TROLL 500
Temperature ranges ¹	Operational: -20-80° C (-4-176° F) Storage: -40-80° C (-40-176° F) Calibrated: -5-50° C (23-122° F)
Diameter	1.83 cm (0.72 in.)
Length	21.6 cm (8.5 in.)
Weight	124 g (0.27 lb)
Materials	Titanium body; Delrin nose cone
Output options	Modbus/RS485, SDI-12, 4-20 mA
Battery type & life ²	3.6 V lithium; 10 years or 2M readings
External power	8-36 VDC
Memory	2.0 MB
Data records ³	130,000
Data logs	50
Log types	Linear, Fast Linear, and Event
Fastest logging rate & Modbus rate	2 per second
Fastest SDI-12 & 4-20 mA output rate	1 per second
Real-time clock	Accurate to 1 second/24-hr period
Sensor Type/Material	Piezoresistive; titanium
Calibrated Range (Usable Depth)	<i>Gauged (vented)</i> 5 psig (3.5 m, 11.5 ft) 15 psig (11 m, 35 ft) 30 psig (21 m, 69 ft) 100 psig (70 m, 231 ft) 300 psig (210 m, 692 ft) 500 psig (351 m, 1153 ft)
Burst pressure	Max. 2x range; burst > 3x range
Accuracy (FS) ⁴	±0.05%
Resolution	±0.005% FS or better
Long-term stability ⁵	< 0.1% FS
Units of measure	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH ₂ O, inH ₂ O Level: in, ft, mm, cm, m
Temperature Sensor	
Accuracy & resolution	±0.1° C; 0.01° C or better
Units of measure	Celsius or Fahrenheit

Warranty	3 years Extended warranties are available for all instruments—call for details
Footnotes	See See page 8.

Level TROLL 700 Instrument

General	Level TROLL 700
Temperature ranges ¹	Operational: -20-80° C (-4-176° F) Storage: -40-80° C (-40-176° F) Calibrated: -5-50° C (23-122° F)
Diameter	1.83 cm (0.72 in.)
Length	21.6 cm (8.5 in.)
Weight	124 g (0.27 lb)
Materials	Titanium body; Delrin nose cone
Output options	Modbus/RS485, SDI-12, 4-20 mA
Battery type & life ²	3.6 V lithium; 10 years or 2M readings
External power	8-36 VDC
Memory	4.0 MB
Data records ³	260,000
Data logs	50
Log types	Linear, Fast Linear, Linear Average, Event, Step Linear, True Logarithmic
Fastest logging rate & Modbus rate	4 per second
Fastest SDI-12 & 4-20 mA output rate	1 per second
Real-time clock	Accurate to 1 second/24-hr period
Sensor Type/Material	Piezoresistive; titanium
Calibrated Range (Usable Depth)	<i>Absolute (non-vented)</i> 30 psia (11 m, 35 ft) 100 psia (60 m, 197 ft) 300 psia (200 m, 658 ft) 500 psia (341 m, 1120 ft) 1000 psia (693 m, 2273 ft) <i>Gauged (vented)</i> 5 psig (3.5 m, 11.5 ft) 15 psig (11 m, 35 ft) 30 psig (21 m, 69 ft) 100 psig (70 m, 231 ft) 300 psig (210 m, 692 ft) 500 psig (351 m, 1153 ft)
Burst pressure	Max. 2x range; burst > 3x range
Accuracy (FS) ⁴	±0.05%
Resolution	±0.005% FS or better
Long-term stability ⁵	< 0.1% FS
Units of measure	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH ₂ O, inH ₂ O Level: in, ft, mm, cm, m
Temperature Sensor	
Accuracy & resolution	±0.1° C; 0.01° C or better
Units of measure	Celsius or Fahrenheit
Warranty	3 years Extended warranties are available for all instruments—call for details
Footnotes	See See page 8.

Level TROLL 700H Instrument

Comply with the Office of Surface Water by using the most accurate pressure transducer available. The Level TROLL 700H meets the surface-water specification of ± 0.01 foot.

For accuracy under all operating conditions, instruments are calibrated over the full pressure and temperature range. Each instrument includes a serialized, NIST-traceable calibration report.

General	Level TROLL 700H
Temperature ranges ¹	Operational: -20-80° C (-4-176° F) Storage: -40-80° C (-40-176° F) Calibrated: 0-40° C (32-104° F)
Diameter	1.83 cm (0.72 in.)
Length	21.6 cm (8.5 in.)
Weight	124 g (0.27 lb)
Materials	Titanium body; Delrin nose cone
Output options	Modbus/RS485, SDI-12, 4-20 mA
Battery type & life ²	3.6 V lithium; 10 years or 2M readings
External power	8-36 VDC
Memory Data records ³ Data logs	4.0 MB 260,000 50
Log types	Linear, Fast Linear, Linear Average, Event, Step Linear, True Logarithmic
Fastest logging rate & Modbus rate	4 per second
Fastest SDI-12 & 4-20 mA output rate	1 per second
Real-time clock	Accurate to 1 second/24-hr period
Pressure Sensor Type/Material	Piezoresistive; titanium
Calibrated Range (Usable Depth)	<i>Gauged (vented)</i> 15 psig (11 m, 35 ft)
Burst pressure	Max. 2x range; burst > 3x range
Accuracy ⁵	± 0.01 foot up to 15 ft and $\pm 0.1\%$ of reading > 15 ft
Resolution	$\pm 0.005\%$ FS or better
Units of measure	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH ₂ O, inH ₂ O Level: mm, cm, m, in, ft,
Temperature Sensor	
Accuracy & resolution	$\pm 0.1^\circ$ C; 0.01° C or better
Units of measure	Celsius or Fahrenheit
Warranty	3 years Extended warranties are available for all instruments—call for details
Footnotes	See See page 8.

BaroTROLL Instrument

The titanium BaroTROLL measures and logs barometric pressure and temperature. Use the BaroTROLL in conjunction with non-vented In-Situ Instruments.

Win-Situ BaroMerge Software simplifies post-correction of water level data by automatically subtracting barometric readings from data collected by a non-vented instrument to compensate for changes in pressure due to barometric fluctuations.

General	BaroTROLL
Temperature ranges ¹	Operational: -20-80° C (-4-176° F) Storage: -40-80° C (-40-176° F) Calibrated: -5-50° C (23-122° F)
Diameter	1.83 cm (0.72 in.)
Length	21.6 cm (8.5 in.)
Weight	124 g (0.27 lb)
Materials	Titanium body; Delrin nose cone
Output options	Modbus/RS485, SDI-12, 4-20 mA
Battery type & life ²	3.6 V lithium; 10 years or 2M readings
External power	8-36 VDC
Memory Data records ³ Data logs	1.0 MB 65,000 2
Log types	Linear
Fastest logging rate & Modbus rate	1 per minute
Fastest SDI-12 & 4-20 mA output rate	1 per second
Real-time clock	Accurate to 1 second/24-hr period
Sensor Type/Material	Piezoresistive; titanium
Calibrated Range (Usable Range)	30 psia (usable up to 16.5 psi, 1.14 bar)
Burst pressure	Vacuum/over-pressure above 16.5 psi damages sensor
Accuracy @ 15° C ⁴	±0.1% FS
Accuracy (FS) ⁵	±0.2% FS
Resolution	±0.005% FS or better
Units of measure	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH ₂ O, inH ₂ O
Temperature Sensor	
Accuracy & resolution	±0.1° C; 0.01° C or better
Units of measure	Celsius or Fahrenheit
Warranty	3 years Extended warranties are available for all instruments—call for details
Footnotes	See See page 8.

RuggedCable System

General	RuggedCable System
Operating temp. range	-25° to 80° C (-13° to 176° F)
Jacket options	TPU (thermoplastic polyurethane) Tefzel (ETFE fluoropolymer; generic equivalent to Teflon)
Vent options	Non-vented (absolute) Vented (gauged) with desiccant (used to mitigate moisture/humidity)
Conductors	6 conductors, 24 AWG, polypropylene insulation
Cable diameter	TPU: 6.7 mm (0.265 in.) Tefzel: 6.35 mm (0.25 in.)
Connector diameter	18.5 mm (0.73 in.)
Weight	Non-vented, TPU: 16 kg/300 m (35.6 lbs/1,000 ft) Non-vented, Tefzel: 14 kg/300 m (32 lbs/1,000 ft) Vented, TPU: 14 kg/300 m (32 lbs/1,000 ft) Vented, Tefzel: 14 kg/300 m (32 lbs/1,000 ft)
Minimum bend radius	2X cable diameter (13.5 mm; 0.54 in.)
Break strength	127 kg (280 lbs)
Maximum cable length	1,219 m (4,000 ft) for RS485
Desiccant pack (required for vented systems)	Large and extra large desiccant packs available with titanium, ABS, or stripped-and-tinned termination.
Warranty	2 years
	Specifications are subject to change without notice.

Suspension Wire

General	Suspension Wire
Material	304 stainless steel, 7 x 7 strand
Coating	15 mil polyester elastomer insulation
Weight	0.28 kg / 30 m (0.60 lb / 100 ft)
Break strength	122 kg (270 lb) with proper clip tightening
	Specifications are subject to change without notice.

About the Pressure/Level Sensor

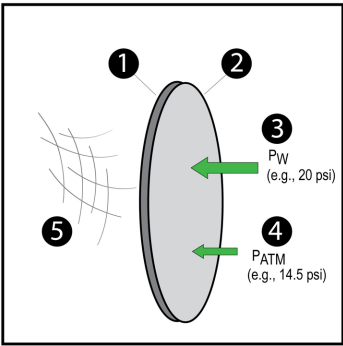
A pressure transducer senses changes in pressure, measured in force per square unit of surface area, exerted by water or other fluid on an internal media-isolated strain gauge. In-Situ offers instruments with either absolute (non-vented) or gauged (vented) pressure sensors.



The "Absolute vs. Gauged: Comparing Absolute and Gauged Pressure Sensors" technical note describes the difference between absolute and gauged pressure sensors and explains the proper use of each type of sensor in different applications.

Absolute Pressure Sensor

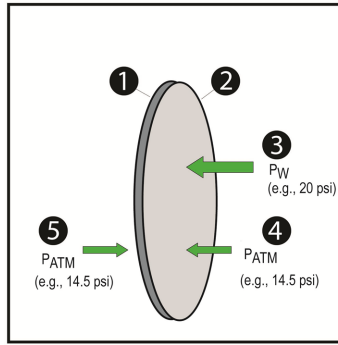
An absolute or non-vented pressure sensor measures all pressure forces detected by the strain gauge, including atmospheric pressure (P_{ATM}). The unit of measure is PSIA (pounds per square inch absolute), measured with respect to zero pressure. The back of an absolute pressure sensor is sealed from the atmosphere. Therefore, the front of the absolute pressure sensor responds to both atmospheric pressure and the pressure head of water above the sensor.



	Absolute Sensor
1	Sensor back
2	Sensor front
3	Water pressure, P_W (e.g., 20 PSI)
4	Atmospheric pressure P_{ATM} (e.g., 14.5 PSI)
5	Vacuum

Gauged Pressure Sensor

A gauged or vented pressure sensor eliminates the effects of atmospheric pressure because the vent tube in the cable allows atmospheric pressure to be applied to the back of the sensor. The unit of measure is PSIG (pounds per square inch gauge), measured with respect to atmospheric pressure.

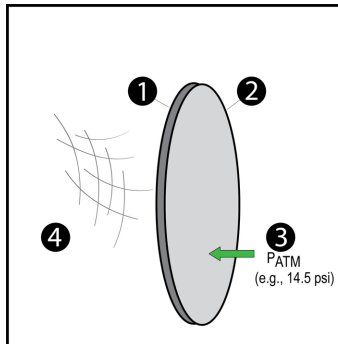


Gauged Pressure Sensor

1	Sensor back
2	Sensor front
3	Water pressure, P_W (e.g., 20 PSI)
4	Atmospheric pressure P_{ATM} (e.g., 14.5 PSI)
5	Atmospheric pressure P_{ATM} (e.g., 14.5 PSI)

BaroTROLL Atmospheric Pressure Sensor

Barometric pressure applies a direct stress upon open wells and surface water. Locally, barometric effects can change significantly from location to location as a result of topographical and micro-meteorological changes. Therefore, it is important to compensate for the barometric pressure changes when monitoring water elevation.



BaroTROLL Sensor

1	Sensor back
2	Sensor front
3	Atmospheric pressure P_{ATM} (e.g., 14.5 PSI)
4	Vacuum

Configuring Depth and Level for PLC or Data Logger

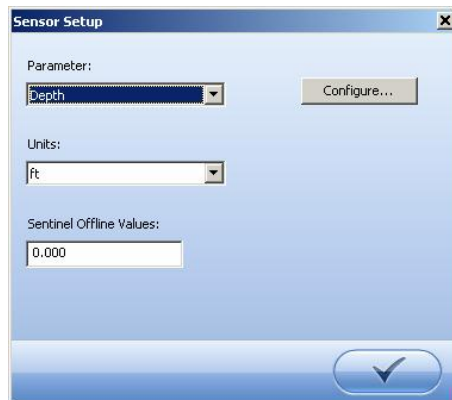
When you configure level using the **Sensors** tab, the settings are stored in the instrument and are available for use in Modbus, SDI-12, or 4-20 mA analog communication. A different configuration can be selected when you set up a log.

1. Connect the instrument to the software.

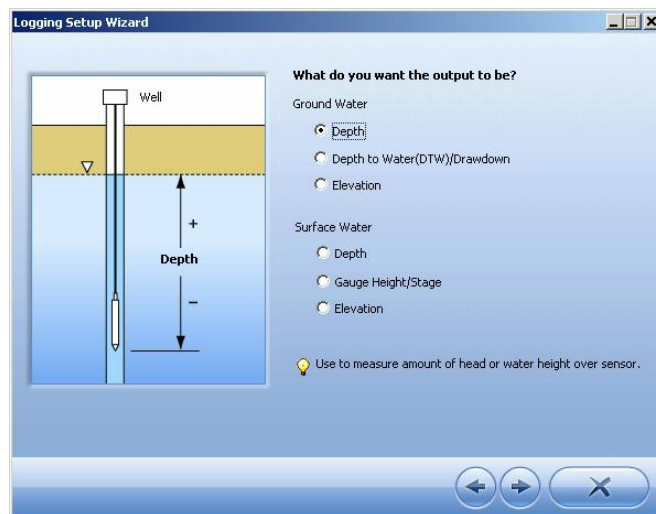
2. Click the **Sensors** tab



3. Select the level/pressure sensor and click the **Configure** button. The Sensor Setup window appears.



4. In the **Sensor Setup** window, select the Level parameter, then click **Configure** The Level Setup Wizard opens.



5. In the Level Setup Wizard, select the options you want. For more information, view the Help in the Win-Situ 5 Software.

System Components

Instrument

The Level TROLL Instrument is completely sealed and contains no user-serviceable parts. The instrument includes pressure and temperature sensors, a real-time clock, microprocessor, sealed lithium battery, data logger, and memory. Options include a vented or non-vented pressure sensor in a variety of ranges.

RuggedCable System

RuggedCable Systems are custom-built, durable, direct-read cables that include the following items.

- Titanium twist-lock connectors for quick, reliable connections to the instrument, desiccant, and communication cable
- Metal shield beneath the cable jacket to prevent electrical interferences
- Kellems grip for secure instrument deployment
- Small desiccant for vented systems (for storage only)



Non-vented cables are marked with VF, which means vent free.

Vented or Non-Vented Cable

Vented cable is used with vented pressure sensors to produce gauged measurements. The cable vent tube ensures that atmospheric pressure is applied to the back of the sensor diaphragm.

Non-vented cable is used with non-vented instruments for absolute measurements. Compensate absolute measurements by using a BaroTROLL Instrument and Win-Situ Baro Merge Software.



Vented cable is shipped with a small desiccant to protect against condensation. Larger desiccants are necessary for deployment.

Jacket Options

Tefzel (vented) or thermoplastic polyurethane (TPU, vented or non-vented)

Customizable Cable Lengths

Cables can be ordered up to 1,219 m (4,000 ft).

Cable Termination

Cables can be ordered with a twist-lock termination (female connector) on both ends that connect to the instrument, the TROLL Com Communication Device, desiccant, and other accessories.

Cables can also be ordered with stripped-and-tinned termination for wiring to a data logger or controller using SDI-12, analog (4-20 mA), or Modbus communication protocol.



1	RuggedCable System with female to female connectors
2	Stripped-and-tinned RuggedCable System with female connector
3	Stripped-and-tinned RuggedCable System with male connector (short length that converts a cable with a twist-lock connector to a stripped-and-tinned cable)

Suspension Wire

Polyurethane-coated stainless steel suspension cable can be used to deploy instruments with non-vented pressure sensors such as the Level TROLL 400 Instrument, the non-vented Level TROLL 700 Instrument, and the BaroTROLL Instrument. Suspension wire is appropriate to use when direct communication with the instrument is not necessary during deployment.



Description	Part Number
Suspension Wire - 300 feet	0066450
Suspension Wire - 150 feet	0066460
Suspension Wire - 50 feet	0066470

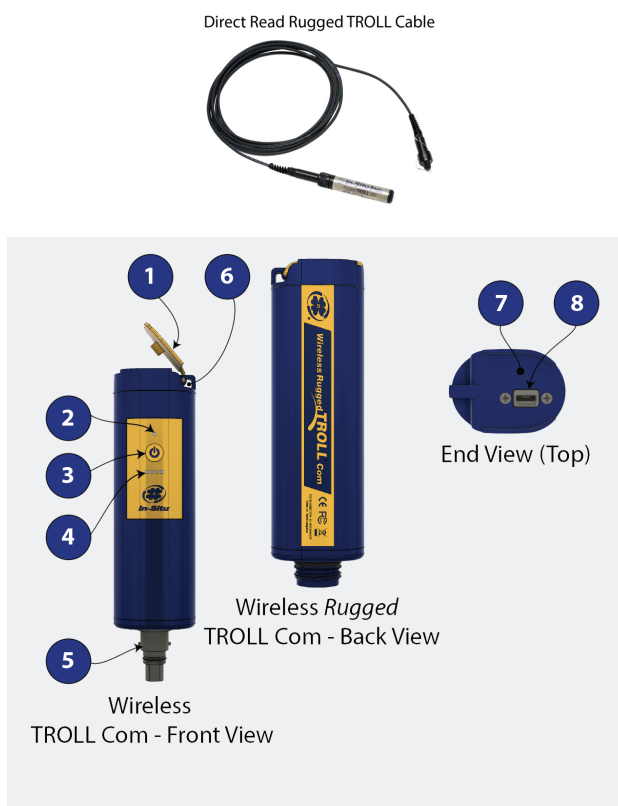
Communication Cables






The TROLL Com Communication Device provides an interface between the instrument and a desktop/laptop PC for calibrating and programming the instrument and for profiling and downloading data. The TROLL Com Communication Device is offered in either a cable-connect or direct-connect configuration including a 0.9 m (3 ft) vented polyurethane cable, external power input jack, and vent with replaceable membrane.

Description

The *Wireless TROLL Com* enables wireless communication between a Bluetooth 2.0-enabled Android or Windows device and an instrument deployed on a cable. You can also use the Wireless TROLL Com as a replacement for a standard wired TROLL Communication Device.

The *Wireless Rugged TROLL Com* permits wireless transmission between a Bluetooth 2.0-enabled device and a Rugged TROLL data logger. You must use a Direct Read Rugged TROLL cable with the Wireless Rugged TROLL Com.



1	Dust cover for the USB connection
2	<p>Connection status</p> <p>Red (flashing) = The communication device, instrument, and Bluetooth-enabled device are not connected.</p> <p>Red (continuous) = The communication device and instrument are connected, but the communication device is not connected to the Bluetooth-enabled device.</p> <p>-OR-</p> <p>The communication device is connected via USB cable.</p> <p>Green (flashing) = The communication device is connected to the Bluetooth-enabled device, but is not connected to the instrument.</p> <p>Green (continuous) = The communication device, instrument, and Bluetooth-enabled device are connected.</p>
3	On/Off button
4	<p>Battery charge status:</p> <p> 100% - 90%</p> <p> 90% - 75%</p> <p> 75% - 50%</p> <p> 50% - 25%</p> <p> Less than 25%</p>
5	Cable connector to the instrument
6	Lanyard connector
7	Serial number
8	USB connection to a power source for charging the internal battery or wired connection to a computer

Contents

- Wireless TROLL Com
- USB cable
- AC wall charger (U.S.A. only, universal charger sold separately)
- Lanyard

Charging the Communication Device

1. Remove the protective cover from the USB slot.
2. Connect the USB cable to the device.
3. Plug the USB cable into the wall charger or a powered USB port such as a computer that has a charger plugged in.
4. The device lights will turn on and blink according to charge level.

A fully-charged communication device will run for up to 40-50 continuous hours.

Battery Tips

The communication device uses an internal, rechargeable Lithium-ion (Li-ion) battery to supply power. While these batteries last for years with minimal decrease in performance, there are a few tips to prolong the life of the battery.

-
- Avoid full discharges and charge the battery more often between uses.
 - Avoid storing the communication device in a high temperature (above 86° F / 30° C) area.

Connecting to a Wireless TROLL Com

A Wireless TROLL Com can be used to connect the instrument to software if the sonde is deployed on a cable.

1. Turn on the Wireless TROLL Com.
2. Make sure the cable is connected to the instrument as well as the communication device.
3. Go to Bluetooth settings on your mobile device or computer.
4. From the Bluetooth section, search for devices.
5. Tap or click the serial number of the communication device to pair the device with the phone or computer. The serial number is located under the USB flap.

Connecting to VuSitu

1. Open the VuSitu Mobile App. If you have correctly paired your Wireless TROLL Com with your wireless device, and the instrument is available, the software will connect and display readings.



If the Searching screen continues to show, tap "Choose another device" and select the device you are trying to connect to.

Connecting to Win-Situ 5

1. Open Win-Situ 5 Software.
2. When prompted, "Connect to device now?" click **No**.
3. Plug the USB charging cable into the computer and Wireless TROLL Com.
4. Click **Preferences**, then click **Comm Settings**.
5. Select the correct Com port used by the charging cable, then select the communication settings for the instrument you are connecting. The following default communication settings are most common for In-Situ instruments:
 - Baud: 19200
 - Data Bits: 8
 - Parity Bits: Even
 - Stop Bits: 1
 - Device Address: 1
 - Mode: Modbus-RTU

If you cannot connect using these settings, click the "Search for Devices" or "Reset All Devices" button.

6. Click the checkmark, then click the Connect button in the lower right hand corner.

Power Options

Internal Power—Batteries

Internal batteries are not user-replaceable. The approximate percentage of the power remaining in an internal battery is displayed on the Home Screen when an instrument is connected to Win-Situ Software.

The instrument is powered by 3.6 VDC, supplied by a sealed, non-replaceable AA lithium battery. Battery life depends on sampling speed. The battery typically lasts for 10 years or 2,000,000 readings, whichever occurs first.

When an instrument is wired to a data logger or PLC controller, power to the instrument is supplied by the data logger or controller.

AC Adapter

The AC adapter provides 24 VDC, 0.75 A, AC input 100-250 V and includes a North American power cord. The TROLL Com Communication Device includes an external power input port for connection to the AC adapter.

Description	Part Number
AC Adapter 24 VDC	0052440



Use only In-Situ Inc.'s AC adapter. Damage to the instrument caused by the use of third-party converters is not covered by the warranty.

External Power—External Battery Packs

External battery packs can significantly increase the life of an instrument, either for long-term deployments or to preserve an aging instrument.

TROLL Battery Pack

The sealed, submersible TROLL Battery Pack supplements internal battery power when an instrument is used for fast, frequent sampling or during long-term deployments. When this power source is connected, the instrument will use the external battery source first and switch to the internal batteries when external battery power is depleted. Total battery life depends on the sampling speed.



Description	Part Number
TROLL Battery Pack	0051450

The sealed, submersible TROLL Battery Pack supplies 14.4 V. When this power source is connected, the Level TROLL will use the external battery source first and switch to the internal batteries when external battery power is depleted.

0.5 second sampling interval	1.2 months
1 second sampling interval	2.3 months
1 minute (or longer) sampling interval	1 year

TROLL Replaceable Battery Pack

The TROLL Replaceable Battery Pack supplements internal battery power when a Level TROLL or Aqua TROLL 100 or 200 Instrument is used for frequent, fast sampling or during long-term deployments. When this power source is connected, the TROLL instrument will use the external battery source first and switch to the internal batteries when external battery power is depleted. Battery life depends on sampling rate. This battery pack allows for 1.5 V UM-3 or size AA batteries (8) that are replaced by the user.



The TROLL Replaceable Battery Pack is not submersible.



Description	Part Number
TROLL Replaceable Battery Pack	0090000

Estimated Battery Lifetime

<i>TROLL Battery Pack</i>	Level TROLL Family
15 minute logging rate*	1.1 years
1 hour logging rate*	1.1 years

*Logging with all sensors. Actual battery lifetime varies based on site conditions.

<i>TROLL Replaceable Battery Pack</i>	Level TROLL Family
15 minute logging rate*	1.6 years
1 hour logging rate*	1.7 years

*Logging with all sensors. Actual battery lifetime varies based on site conditions.

Installation Accessories

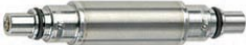
NPT Adapter

The 0.25 in. NPT adapter allows instrument installation in piping.

Part Number	Image	Description
0051470		NPT Adapter

Cable Extender

The cable extender connects two lengths of RuggedCable System to meet varying installation needs.

Description	Image	Part Number
Cable Extender		0051490


Twist-Lock Hanger

The Twist-Lock Hanger is used with a suspension wire to install a non-vented instrument when the user does not require direct communication.

Part Number	Image	Description
0051480		Twist-Lock Hanger, titanium for Level TROLL 400, 700, 700H, BaroTROLL

Bulkhead Connector

The panel-mounted bulkhead connector provides connection between RuggedCable System and a controller panel.

Part Number	Image	Description
0053240		Bulkhead Connector

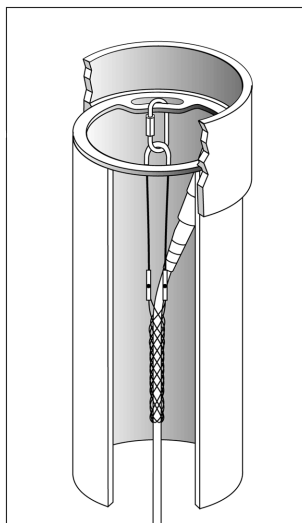
Locking Well Cap



Description	Part Number
Locking Well Cap, 2"	0020360
Locking Well Cap, 2" vented	0020370
Locking Well Cap, 4"	0020380
Locking Well Cap, 4" vented	0020390

Well Dock Installation Ring

The well dock installation ring provides installation support for 2", 4", and 6" well casings.



Description	Part Number
Well Dock Installation Ring 2"	0004690
Well Dock Installation Ring 4"	0004700
Well Dock Installation Ring 6"	0020650

Software

TheLevel TROLL can be programmed using the VuSitu Mobile App for Android, or using Win-Situ 5 Software.

About VuSitu

VuSitu is the mobile user interface and control application for In-Situ water quality instruments. You can use VuSitu on mobile devices with Android operating system 4.4, *Bluetooth* 2.0 and newer. Download the latest version of the app from the Google Play Store at play.google.com.

VuSitu allows you to accomplish the following tasks.

- View live readings that update every 10 seconds
- Change parameters and units
- Set up a data log
- Record data
- Email data in spreadsheet format
- Download data to mobile device
- Transfer data from mobile device to a computer

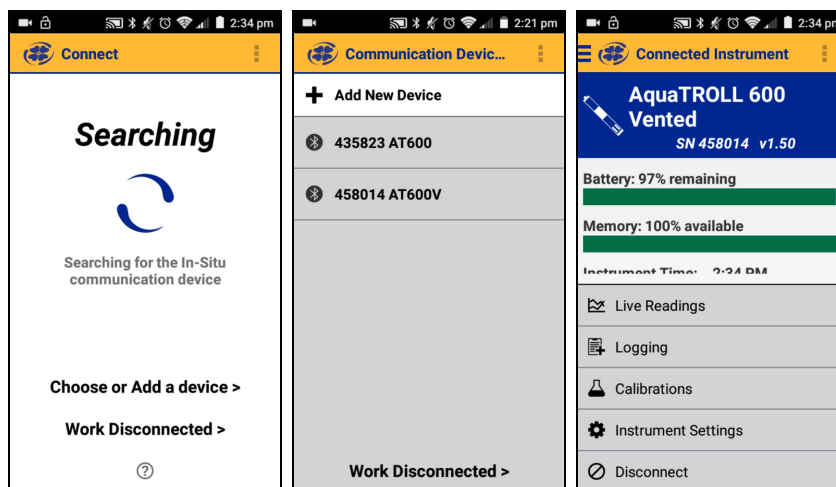
- Organize data by Location
- Calibrate Sensors and View Reports

Connecting Your Instrument to VuSitu

To use VuSitu, you will need a Bluetooth-enabled mobile device, a Wireless TROLL Com and a deployment cable.

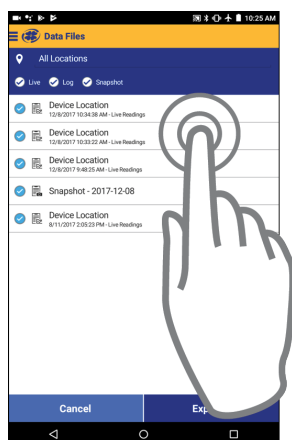
Attach one end of the cable to the Wireless TROLL Com and secure the other end to the instrument. Press the power button on the Wireless TROLL Com and open the VuSitu mobile app on your phone or tablet.

VuSitu will automatically search for Bluetooth devices nearby, but you will need to select the correct instrument when connecting for the first time. Select **Choose or Add a Device**. You should see the serial number of the instrument you wish to pair. Tap the serial number to connect. Tap the **Back** button on your device to view the Connected Instrument screen.



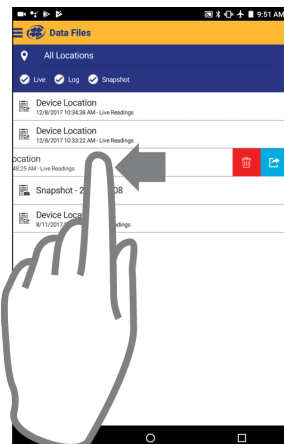
Selecting with Long-press and Swipe

Long Press



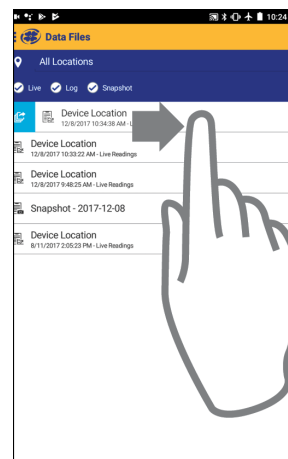
Press and hold any item in a list of files. You can now select multiple files.

Swipe Left



Press an item and swipe left to reveal the delete and share icons.

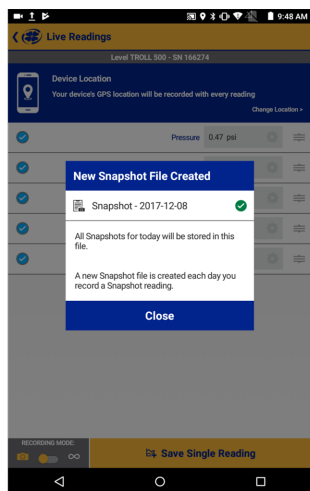
Swipe Right



Press any item in a list and swipe right to reveal the sharing icon.

Taking live readings in VuSitu

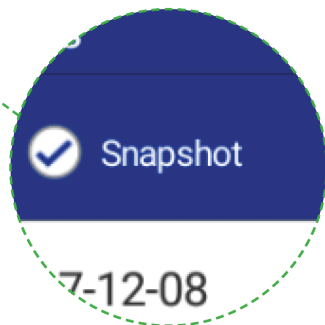
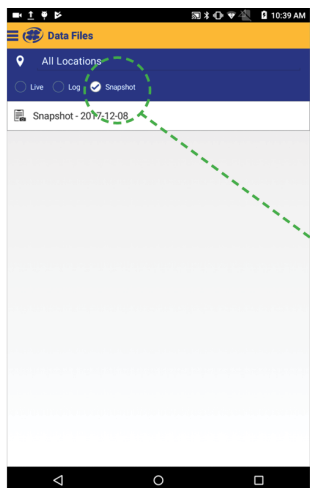
Snapshot Mode



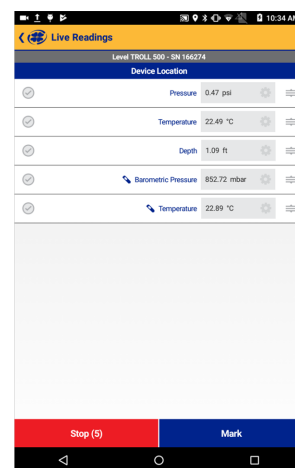
Take a single reading and save to Snapshot file.

View Snapshot file from Menu > Data Files.

Check Snapshot option.



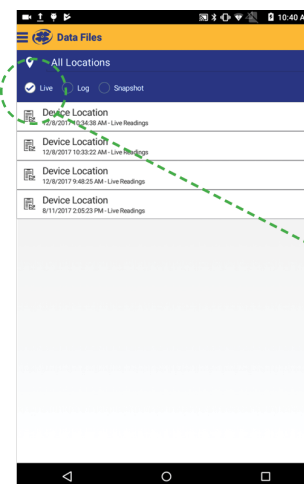
Live Readings Mode



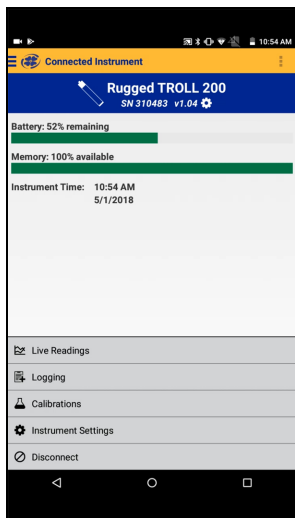
Take readings at two-second intervals.

View readings from Menu > Data Files.

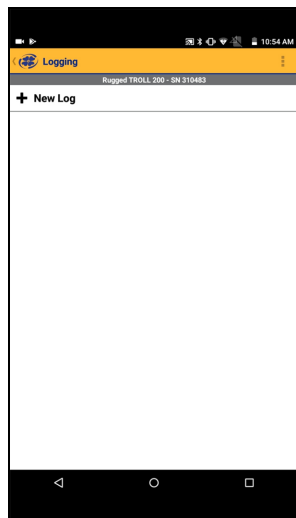
Check Live option.



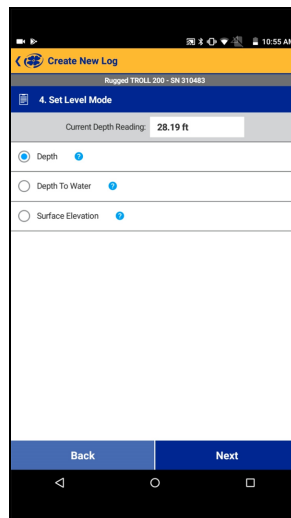
Setting Up a Log



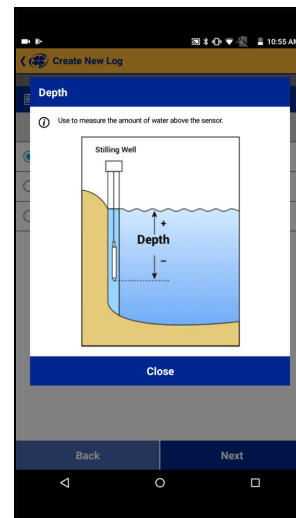
From the Connected Instrument screen, select **Logging**.



Tap **New Log** and follow the prompts to create a name, select a location and choose the parameters you wish to monitor.



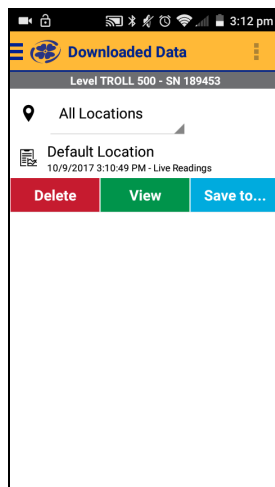
Select a level mode in step 4. Tap the blue circle to the right of each option for an explanation of how the mode works.



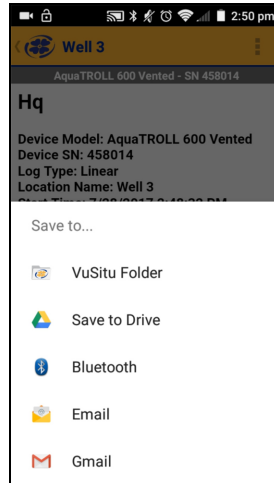
For Depth to Water and Surface Elevation modes, enter a level reference. See "About the Level Reference" on page 55 of this manual for complete information about level modes and level references.

Downloading and sharing your data.

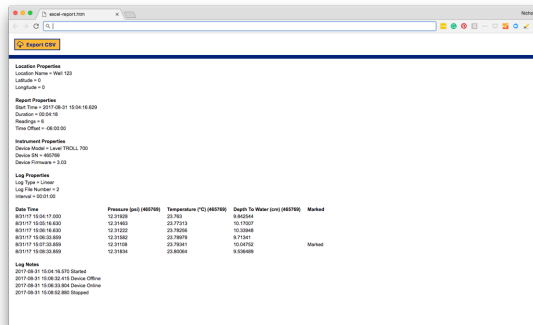
You can download VuSitu data as an HTML file and share it via email, SMS or a cloud storage service such as Google Drive. To download a log, select it from the Downloaded Data screen and tap **Save to**.



Choose one of the download options from the menu. You can transfer a data file from your mobile device to a PC via Bluetooth, email it to yourself or any valid email address, save the file to the VuSitu folder on your device or upload it to Google Drive.



View your data in any web browser by double-clicking the file. You can then export a CSV file by clicking the **Export a CSV** link at the top of the page.



Getting Started

This section provides an overview of the initial steps necessary to prepare the instrument to log data.

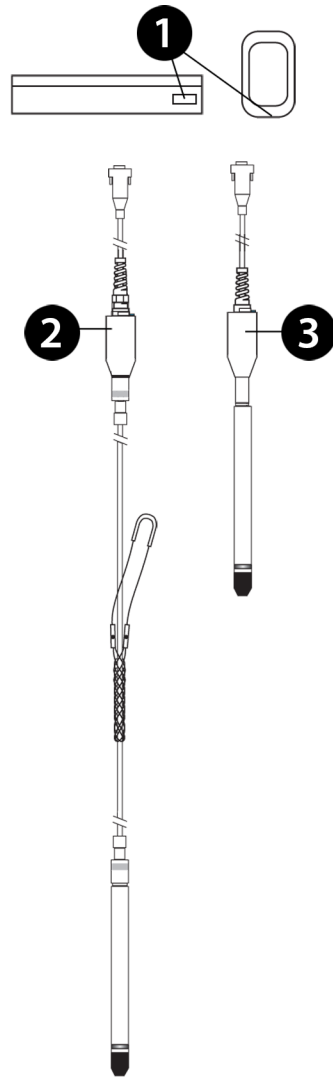
- Select the appropriate TROLL Com Communication Device. This determines the hardware connections, and may influence the software installation. The drawing on the following page shows the function of the different TROLL Com Communication Device models.
- Install the software.
- Connect the hardware.
- Open the software and establish communication with the instrument.

Select a TROLL Com Communication Device

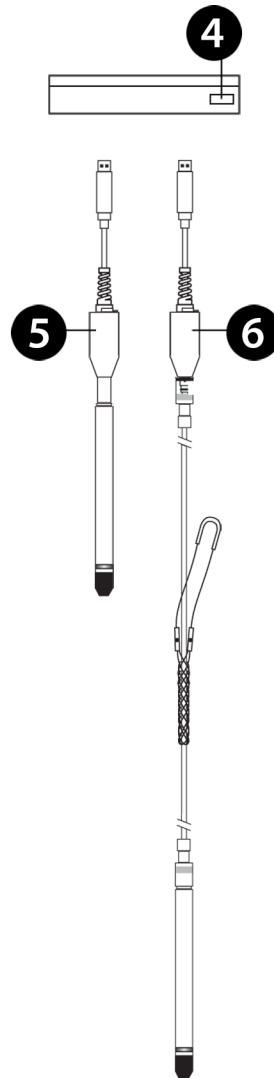
The subsequent figure shows the function and connection features of the TROLL Com Communication Device models.

- A Direct-Connect TROLL Com might be preferred for programming an instrument that will be deployed on a suspension cable.
- A RuggedCable System and a Cable-Connect TROLL Com are required if you intend to communicate with the instrument while it is deployed. However, you can program the instrument with any TROLL Com.
- A Wireless TROLL Com will allow you to connect to the VuSitu mobile app, which you can use to configure and deploy your instrument.

RS232



USB



1	Cable-Connect TROLL Com Communication Device, serial connection, for field use
2	Direct-Connect TROLL Com Communication Device, serial connection, programming only, not submersible
3	USB port on a PC/laptop
4	Direct-Connect TROLL Com Communication Device, USB connection, programming only, not submersible
5	Cable-Connect TROLL Com Communication Device, USB connection, for field use

Connecting RuggedCable

Connect the Instrument to the RuggedCable

1. Remove the protective caps from the instrument and cable. Ensure that the O-ring on the instrument connector is clean. Apply a small amount of vacuum grease to the o-ring.
2. Position the instrument and cable flat edges so they will connect properly. Insert the instrument connector firmly into the cable connector.



3. Hold the textured section of the sleeve in one hand and the instrument in the other. Push and twist until you hear a click. The click ensures the cable and instrument are securely attached.



Connect TROLL Com Communication Device to the RuggedCable System

1. If a desiccant is present, remove the desiccant from the cable. Twist the desiccant and cable sleeve in opposite directions to unlock the desiccant from the cable.
2. Position the TROLL Com and cable flat edges so they will connect properly. Push and twist until you hear a click.

Install the Software

Win-Situ 5 Software

Install Win-Situ 5 Software from the In-Situ software/resource CD or from the In-Situ website. Click the Win-Situ 5 link, and follow the instructions to install Win-Situ 5 to your local hard drive.

USB TROLL Com Drivers

If you are using a USB TROLL Com Communication Device, be sure to select the option "Install USB TROLL Com Drivers" during the Win-Situ 5 installation. Two drivers will be loaded to your hard drive, one for the USB TROLL Com, one for the USB TROLL Com serial port.

Field Deployment

Program the Instrument

In order to set up a log or download data, you must connect the instrument to a computer running Win-Situ 5 software or to a mobile device with the VuSitu app. See page 52.

Position the Instrument

Place the instrument at the desired depth. Position the instrument below the lowest anticipated water level, but not so low that the pressure sensor range might be exceeded at the highest anticipated water level. Refer to the tables below to determine usable depth.



A BaroTROLL Instrument can be deployed with a non-vented instrument to compensate level data for changes in atmospheric pressure. Make sure the clocks on both instruments are synchronized, and install the BaroTROLL in a location that will never be submerged in water. See page 41.

Non-Vented Level TROLL Instrument

Range	Effective Range		Usable Depth	
	PSIA	kPA	Meters	Feet
30	15.5	106.9	11	35
100	85.5	589.5	60	197
300	285.5	1968	200	658
500	485.5	3347	341	1120
1000	985.5	6795	693	2273

* Effective range for psia sensors is limited by an estimated 14.5 PSI atmospheric pressure at sea level.

Vented Level TROLL Instrument

Range		Usable Depth	
PSIG	kPA	Meters	Feet
5	34.5	3.5	11.5
15	103.4	11	35
30	206.8	21	69

Range		Usable Depth	
100	689.5	70	231
300	2068	210	692
500	3447	351	1153

Verify Instrument Depth

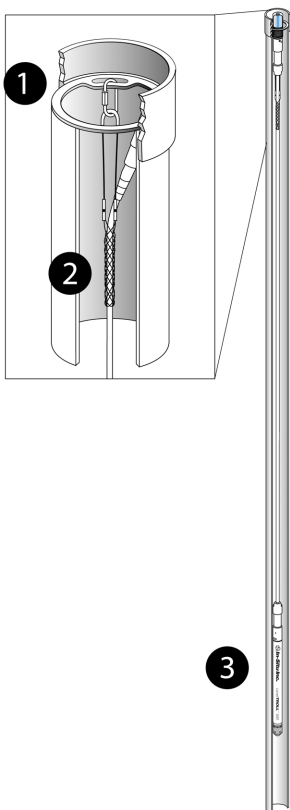
After you have installed the instrument, it is possible to connect the instrument to a computer or mobile device, open the software, and take a reading to verify the installation position. If the reading confirms that the instrument is in the correct position, you can secure it as described below.

During log setup there was an option to "Remind Me Later" for setting a level reference. If you set the log to remind you later, ensure that the instrument is submerged and set the level reference when prompted. See page 55.

Secure the Cable

The RuggedCable System includes a Kellems grip near the up-hole end. You can compress the wire mesh and slide the grip to the desired location on the cable. Pull on the grip to tighten it on the cable.

Use the loop on the Kellems grip to anchor the cable to a convenient stationary object such as the In-Situ well dock installation ring. To install the Kellems grip to the installation ring, insert the loop into the locking clip on the well dock and position the assembly at the top of a well casing.



1	Well Dock Installation Ring
2	Kellems Grip
3	Instrument Installed in Well

Install the Desiccant



Vented cable must be protected with a desiccant pack that is properly sized for site conditions.

Desiccant

Desiccant protects cables, connections, and internal components from condensation, which can cause irreparable damage and loss of data. Indicating desiccant changes from blue to pink as it becomes saturated with moisture.



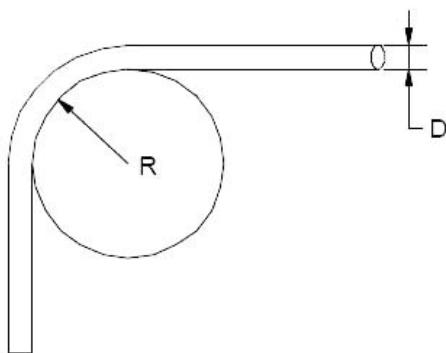
Desiccant stages (from left)

New, nearly expired (replace now), expired

It is **extremely important** to use a properly-sized desiccant for your deployment and to **change desiccant often**. Desiccant should be changed before the entire volume has turned pink, and you should use enough desiccant to effectively keep your equipment dry until your next scheduled maintenance. Desiccant longevity is dependent on site conditions and can vary from one site to the next.

Installation Guidelines

- Never let the instrument fall freely down a well. Doing so will damage the sensor.
- After you have installed the instrument, verify the water level reading. Move the instrument and take another reading to ensure that the instrument shows reasonable change. The instrument could be wedged against the well casing with a loop of cable hanging below. An instrument in such a position could become dislodged and move while it is logging data, which would record a false change in the water level.
- For accurate measurements, the instrument should remain immobile while it is logging data.
- Make sure that the uphole cable end is protected. The vented cable must be protected with a desiccant, and the non-vented cable must be protected with a dust cap. The uphole cable end must be positioned above the highest anticipated water level. Avoid placing this end in a location that might flood.
- Do not deploy instruments in such a way that ice may form on or near the sensor or cable connections. Ice formation is a powerful expansive force that can over-pressurize the sensor or otherwise cause damage. Damage associated with ice formation is not covered by the instrument warranty.
- Do not allow vented cable to bend enough to obstruct the internal vent tube. The recommended bend radius is 13.5 mm (0.54 in), which is twice the cable diameter.



R	Bend radius 13.5 mm (0.54 in)
D	Cable diameter

Stabilization Time

After you have installed the instrument, allow it to stabilize to the environment for about 10 minutes before logging data. The T95 response time for temperature is less than 9 minutes.

A generous stabilization time is always desirable, especially in long-term deployments. Even though the cable is shielded, temperature stabilization, stretching, and relaxing can cause changes to readings.



If you intend to monitor water levels to the instrument's stringent accuracy specifications, allow up to 60 minutes for the probe and cable to stabilize to the environment.

BaroTROLL Instrument Installation

The BaroTROLL Instrument is designed to log barometric pressure from 0 to 16.5 PSIA (1.14 bar, 33.59 inHg) at the surface near a submerged non-vented Level TROLL Instrument or Aqua TROLL 200 Instrument. BaroTROLL data may then be used to correct the water level data for barometric pressure fluctuations. See page 15.



Programming the Baro TROLL Instrument

Connect the BaroTROLL to Win-Situ 5 software or the VuSitu mobile app and sync the clock. See page 53.

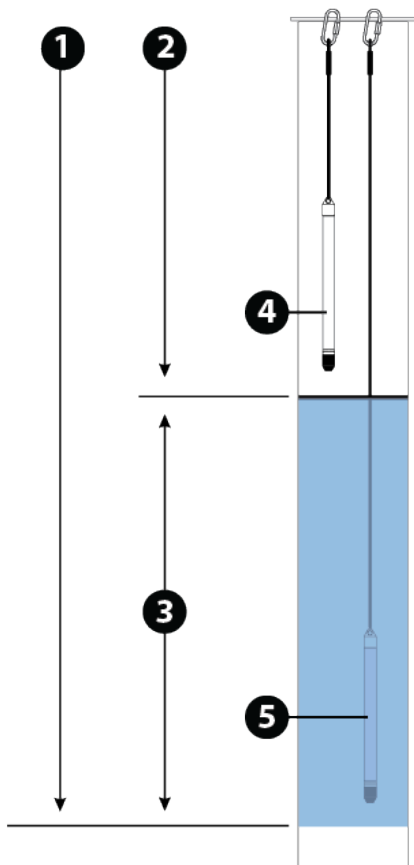
Set up a log with the same start time and sample interval as you set up in the non-vented level instrument. See page 54.

Installation

After the BaroTROLL Instrument is programmed, install it in a protected location above the water level near the submerged water level instrument. One installation configuration option is shown below using a twist-lock hanger and a suspension wire.



To prevent flooding of the BaroTROLL electronics, attach the twist-lock hanger before you install the BaroTROLL. Do not submerge the Baro TROLL Instrument.



1	Atmospheric pressure + water pressure (as measured by a non-vented pressure sensor)
2	Atmospheric pressure (as measured by the BaroTROLL)
3	Water pressure (as measured by a vented pressure sensor, or by subtracting BaroTROLL data from non-vented pressure sensor data)
4	BaroTROLL Instrument (Do not submerge.)
5	Non-vented Level TROLL Instrument

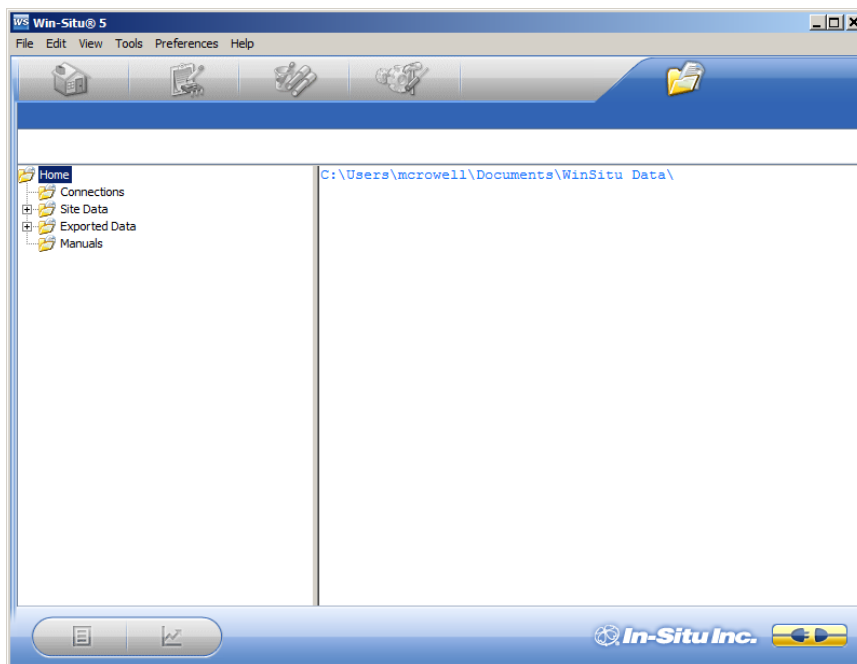







To merge atmospheric pressure data with water level data, See page 59.



Win-Situ Overview

Data Tab

When you open Win-Situ 5 Software, the **Data** tab appears. The left side of the screen contains a file tree where you can view previously downloaded site data as well as data you have exported to Microsoft Office Excel. The links on the right side of the screen show where downloaded data are stored on your computer. The disconnected plug icon in the lower-right corner of the screen indicates that the software is not yet communicating with an instrument.

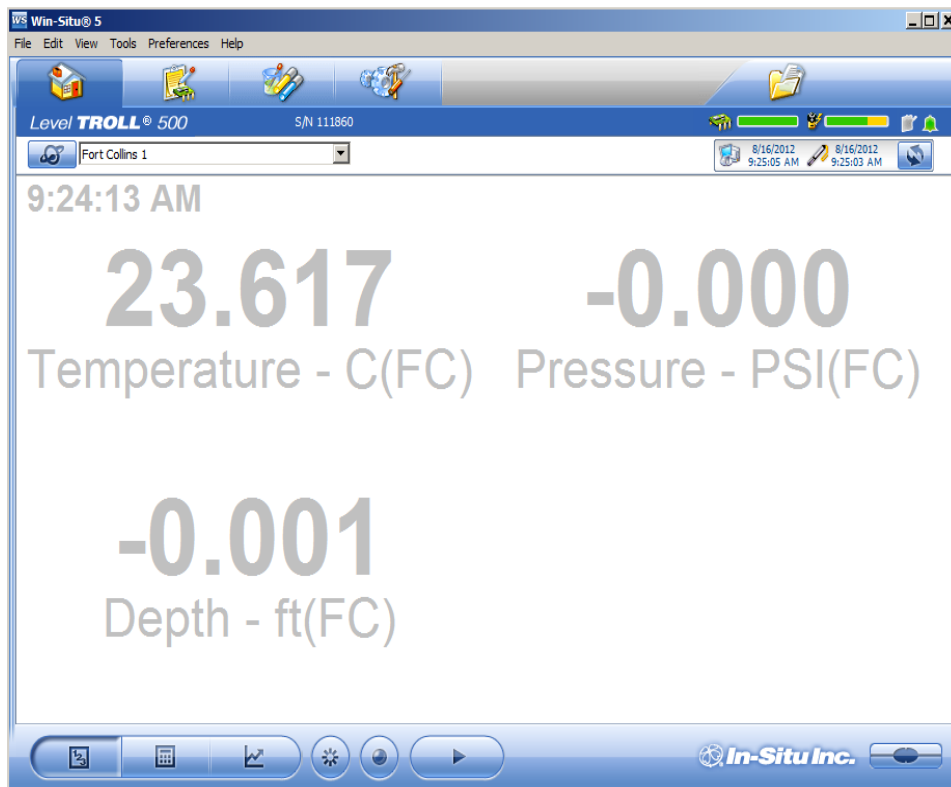





Screen Element	Definition
	The disconnected plug indicates the instrument is not communicating with the software. Click to establish communication with a connected instrument.
	The connected plug indicates the instrument is communicating with the software. Click to disconnect the software from the instrument.
	The Home tab displays real-time readings from the instrument. When connection to the instrument is first established, the software displays one reading of all available parameters in light gray. You must click the Play button  at the bottom of the screen to view real-time readings.
	The Logging tab displays a list of logs stored in the connected instrument. When you click the Logging tab, it can take a moment for the software to retrieve information from the instrument. (Not applicable for the RDO PRO-X and the Aqua TROLL 400.)



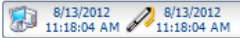




Screen Element	Definition
	<p>The Sensors tab lists the sensors in the connected instrument, along with their serial numbers and the dates of factory calibration and user calibration. Use the buttons in this tab to calibrate sensors that support user calibration and configure sensors that are supported by the instrument.</p>
	<p>The Device Setup tab allows access to instrument information and settings such as instrument name, serial number, firmware version, communication settings, diagnostics, and factory reset options.</p>



Home Tab

The **Home** tab displays real-time readings from a connected instrument. When you first establish communication, the software displays one reading of all available parameters in light gray.



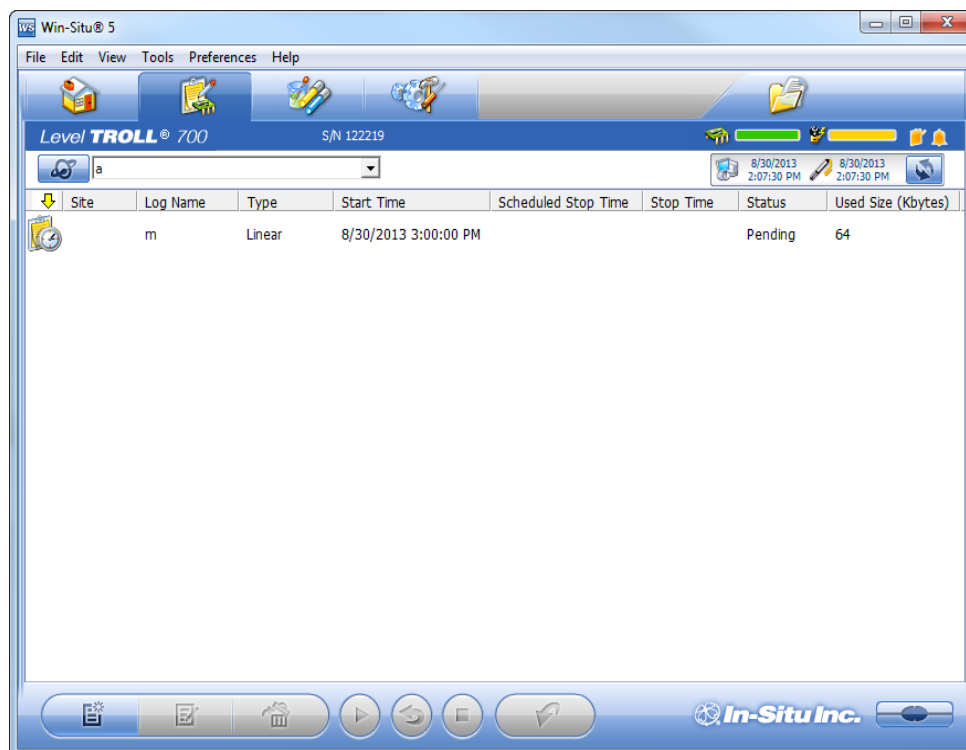
Screen Element	Definition
	The Sites button allows you to add, edit, or delete a site. Click the drop-down arrow next to the button to view the list of sites.
	The Device Memory gauge turns yellow when the internal memory is used. Note: Non-logging instruments do not have internal memory, however, the gauge shows 100 percent green when power is applied.
	The Device Battery gauge turns yellow as the battery is depleted. This example shows 80 percent of the battery remaining (green) and 20 percent used (yellow). Note: Non-logging instruments do not have internal batteries, however, the gauge shows 100 percent green when power is applied.

Screen Element	Definition
	<p>The Logging Status icon:</p> <p>Green—The instrument is actively logging data.</p> <p>Gray—The instrument has no logs pending or running. Non-logging instruments always show a gray status icon.</p> <p>Yellow—The instrument has log data that was collected according to specific instructions in the "Pending" or "Suspended" state.</p>
	<p>The Alarm icon provides additional instrument status information.</p> <p>Green—No alarms or warnings</p> <p>Yellow—One or more warnings</p> <p>Red—One or more alarms</p> <p>Move the cursor over the alarm icon to view a description. Click the Device Setup tab for detailed information on the alarm or warning.</p> <p>Note: Disregard the Device Reset alarm for non-logging instruments such as the RDO PRO Probe or the Aqua TROLL 400.</p>
	<p>System Time is displayed on the left. Device Time is displayed on the right. Clocks are updated once every two seconds. When the Device Time is displayed in red, it differs from the current System Time, and should be synchronized.</p>
	<p>The Time Sync button is used to write the current PC time to the instrument. If you need to set the instrument clock to a time other than the system (PC) time, use the Set Clock button on the Device Setup tab.</p>
	<p>Meter View shows the last known parameter values, displayed with current units and time stamp. Readings are sized to occupy the entire screen. This is the default display in the Home tab. If the type is black, the readings are updating in real time.</p>
	<p>List View is a running list of the most recent records. New readings are continuously added to the top of the list and old readings scroll off the bottom.</p>
	<p>Graph View shows a real-time trend graph of the selected parameters.</p>

Screen Element	Definition
	The Snapshot button records one set of readings.
	The Record button logs data to a CSV file that can be opened in a spreadsheet program. This is not the same as recording data in a log on the instrument.

Logging Tab

The **Logging** tab displays a list of logs in the instrument. When you click the **Logging** tab, it may take a moment for the software to retrieve information from the instrument.



Log Information

Columns across the **Logging** screen show information about the logs in the instrument.

- **Symbol**—This is a graphic representation of the information in the **Status** column.
- **Site**—The site that was specified when the log was configured.
- **Log Name**—The name that was entered when the log was configured.
- **Type**—The logging method that was selected when the log was configured.
- **Start Time**—For a Pending log, the scheduled start time is shown. For a Ready log that has not yet started, this column displays “Manual.” For a Running or Stopped log, the actual start time is shown.
- **Scheduled Stop Time**—For a log with a scheduled stop, the scheduled stop time is shown. For a log without a scheduled stop time, this column is blank.
- **Stop Time**—For a Pending or Ready log, this column is blank. For a Running log, the time of the last data point is shown. For a Stopped log, the actual stop time is shown.
- **Status**—Each log has a specific status. See **Log Status** for details.
- **Used Size**—Kilobytes of instrument memory allocated for this log. For a Pending or Ready log, the current size of the log configuration is shown. For a Completed log, the size of the entire log file is shown. For a Running log, the current size of the log up to the last data point is shown.

Log Status

The status of each log in the instrument is displayed in the Logging tab by a symbol beside the log name, and in the Status column.



Ready—Manual Start log is ready to start.



Pending—Scheduled start log is ready to start at its programmed time, or when you click the **Start** button.



Running—The log is actively logging data.



Suspended—The log has been paused (stopped temporarily).



Stopped—The log has been stopped, either manually or on a schedule.



Deleted—The log has been marked for deletion and will be deleted from the instrument when memory is needed. The software manages this automatically.



Invalid—The log as programmed cannot be run.



Ready, Pending, Running, and Suspended logs are considered active. Only one log can be active in the instrument.

Log Control Buttons

You can control the status of a log by selecting the log and clicking the appropriate button in the **Logging** tab control panel:



The **Start** button starts a **Ready** or **Pending** log, or resumes a **Suspended** log.



The **Pause** button pauses a **Running** log allowing you the option to resume it.



The **Restart** button restarts the selected **Running** log from the beginning. This can be useful during aquifer testing using a logarithmic data collection schedule.



The **Stop** button permanently stops the selected **Running** log.

Log Operations

Use the buttons in the control panel to perform the following actions:



Create a new log.

The **New** button is disabled if a Ready, Pending, Running, or Suspended log is on the instrument. When the instrument contains its maximum number of logs, the New button is unavailable.



Edit (or review) the log configuration for a Ready, Pending, or Invalid log.



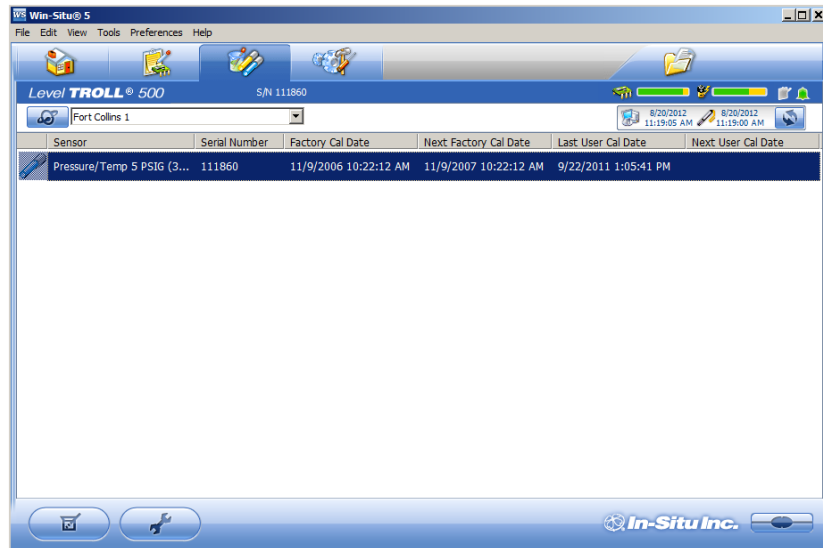
Delete the log. (Note that you must delete a log twice before it is permanently removed.)



Download the log to a PC.


Sensors Tab

The **Sensors** tab lists the sensors in the instrument, along with their serial numbers and calibration dates. Use the buttons in this tab to calibrate and configure sensors.




Calibrate

Use the **Calibration** button to calibrate sensors or to adjust a level reference that is currently stored on the instrument. The **Calibrate** button is not available when the instrument does not support calibration (e.g. BaroTROLL Instrument).

1. With the instrument connected to the software, select the **Sensors** tab.
2. Select the parameter you intend to calibrate.
3. Click the **Calibrate** button .

Configure

Use the **Configure** button to select parameter units and to configure parameters that support configuration. Examples include Level/Depth, Specific Conductivity, and Total Dissolved Solids. Parameters cannot be configured while the instrument is showing live data on the **Home** screen or while the instrument contains an active log.

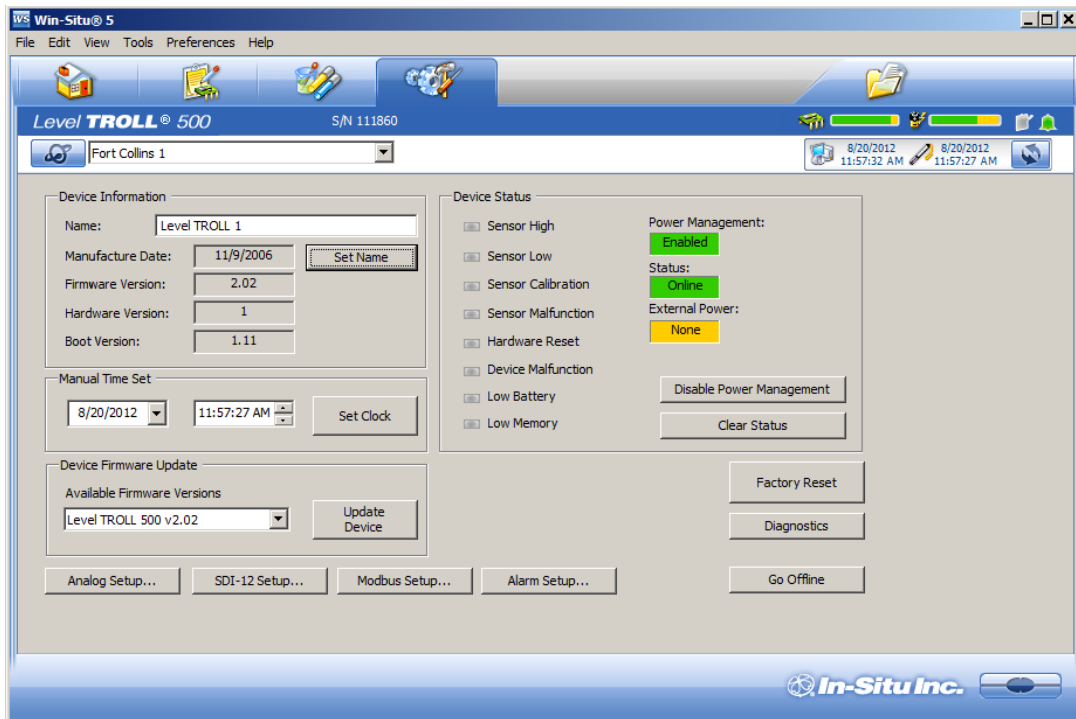
1. With the instrument connected to the software, select the **Sensors** tab.
2. Select the parameter you intend to configure.
3. Click the **Configure** button .



When you configure the Level parameter using the **Sensors** tab, the settings are stored in the instrument and are available for use in Modbus, SDI-12, or analog communication (if available). If desired, a different configuration can be selected when setting up a log.

Device Setup Tab


In general, you should not use the **Device Setup** tab unless you are corresponding with the In-Situ technical support team. However, you can use this screen to set up communication protocols if you are connecting the instrument to a PLC or data logger.



See the online Help for more details.

Using Win-Situ 5 Software

Connecting an Instrument to the Software

When you open Win-Situ 5 Software, you are asked if you want to connect to your device. Click **Yes**. Synchronize the instrument clock to the PC clock. 

The software displays an error message if a connection cannot be established.

Selecting the Correct COM Port

If you are using a USB TROLL Com, select the correct COM port by following the steps below. If you are using a serial TROLL Com, the Win-Situ Software should default to the correct COM port, which is usually COM 1.

Steps for Windows 8.1 and Windows 10 systems.

1. Right-click the **Start** button.
2. Click **Device Manager**.
3. Click the arrow next to **Ports (COM and LPT)**, and locate the USB Serial Port listing. The number listed next to this entry is your COM port address.

Steps for Windows 8 systems.

1. Right-click the **Start** screen.
2. Select **All Apps**.
3. Click **Control Panel**.
4. Open the **Device Manager**.
5. Click the arrow next to **Ports (Com and LPT)**, and locate the USB Serial Port listing. The number listed next to this entry is your COM port address.

Steps for Windows 7 systems.

1. Click the **Start** button, and open the **Control Panel**.
2. Click **Hardware and Sound**, and open the **Device Manager**.
3. Click the arrow next to **Ports (COM and LPT)**, and locate the USB Serial Port listing. The number listed next to this entry is your COM port address.

Steps for Windows XP systems.

1. Click the **Start** button, and open the **Control Panel**.
2. Double-click the **System** icon. Click the **Hardware** tab, and open the **Device Manager**.
3. Click the plus sign next to **Ports (COM and LPT)**, and locate the USB Serial Port listing. The number listed next to this entry is your COM port address.



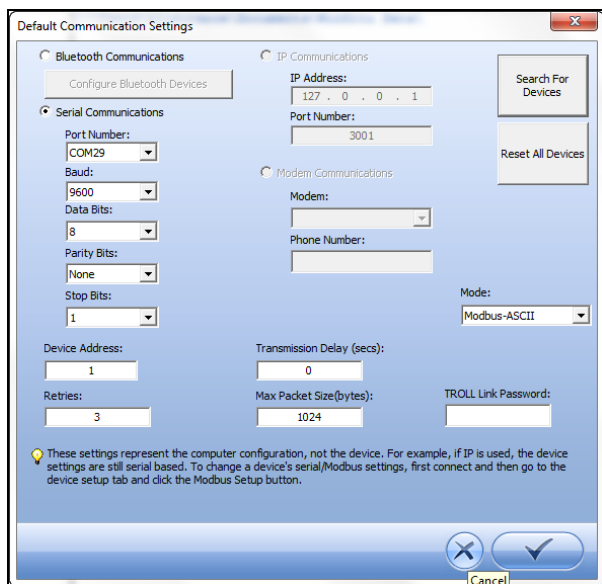
The following steps apply for all Windows operating systems.

1. Once you have determined the correct COM port address in your operating system, reopen Win-Situ 5 Software.
2. Close any open windows in Win-Situ Software.
3. Click **Preferences**.
4. Click **Comm Settings**, and then click the **Port Number** menu.

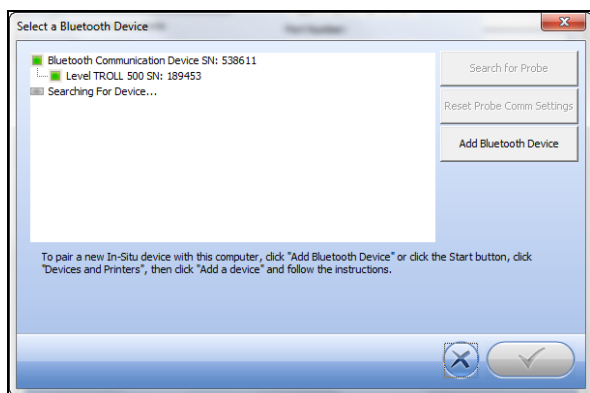
5. Scroll down to find the correct COM port address. Click the **check mark** to accept the changes.
6. Click the yellow **Connect** button in the lower right corner to establish a connection to the instrument.


Bluetooth & Wireless TROLL Com

Connect the cable to the Wireless TROLL Com and the Level TROLL instrument. Turn on the Wireless TROLL Com and open Win-Situ 5. Choose **File > Connect** to access the Default Communication Settings window.



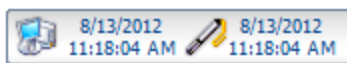
Select the radio button labeled **Bluetooth Communications** and click **Configure Bluetooth Devices**. You will see a list of nearby Bluetooth devices. Click the Wireless TROLL Com you are using and click the check mark.




Finally, click the yellow **Connect** button  at the bottom right of the screen to complete the connection.

Setting the Instrument Time

The instrument time and the current PC time are shown at the top of the screen when an instrument is connected to the software.



The PC time appears on the left, the instrument time on the right. Both clocks are updated at 0.5 Hz (once every two seconds). The device time is displayed in red if it differs by more than a few seconds from the current PC time. Data logging schedules depend on a correct instrument time.

To synchronize the instrument time to the current PC time, click the **Clock Sync** button . Win-Situ writes the current PC time to the instrument.

Adding a New Site

To add a new site to the site database in your working directory do one of the following:

On the **Data** tab, click the **Site Data** folder, select **File> New > Site**.

or



On the **Home** tab, click the **Site** button to display the site list, then click **New**. Enter a name for the site. This is the only required field.

Click **Save** to save the new site. The new site will appear in the **Site Data** folder, and Win-Situ will add it to the site database in the working directory on your computer. It is now available to select for any instrument log.

Log Setup

The Log Setup Wizard presents sequential screens to help you supply all the information necessary to set up a data log in the instrument.

To access the Log Setup Wizard the instrument must be connected to the software.

1. Click the **Logging** tab .
2. Click the **New** button .



The **New** button may be disabled or may show a warning if an active log already exists on the instrument, or if the instrument is polling live data (see the **Home** screen), or if the device already contains its maximum number of logs.

3. Select the **Site** where the set of data will be logged and supply a name for the log.
4. Click the **right arrow** to continue after each step.
5. Select the parameters you intend to measure, choose the measurement units, and specify the order in which the selected parameters will be logged.
6. Select the logging method you intend to use. See page 54.
7. Select the log interval. A log interval is how often a measurement will be taken and stored.
8. Select the start condition, stop condition, and specify how to handle full device memory.
9. If you selected **Level** or **Depth** as a parameter to measure, specify how you intend to log this parameter. See page 55.
10. The final screen summarizes the log setup. Click the **check mark** to write this information to the instrument.

Logging Method Descriptions

The following is a list of log types and their descriptions. The log types that are available on an instrument vary depending upon the capabilities of the instrument.

Logging Methods for Long-Term Monitoring

Linear

Linear log type measures and records at a user-defined fixed interval of one minute or more. This method is used for long-term studies, landfill monitoring, stream gauging, tidal studies, and background monitoring prior to aquifer testing. Intervals are measured in days, hours, or minutes.

Linear Average

Linear Average log type can smooth out anomalous highs and lows that may occur in a data set, for example, when a water wave passes over the instrument. Each stored measurement is the average of several rapid measurements. This method is used for long-term studies, stream gauging, tidal and open-water studies where trends are more important than accuracy. Intervals are measured in days, hours, minutes, or seconds.

Event

Linear Event log type combines basic fixed-interval logging of specified parameters with the ability to log data at a faster interval when a single-parameter event condition is present.

Logging Methods for Aquifer Testing

True Logarithmic

True Logarithmic log type captures early-time water-level data during aquifer testing. Measurements are very closely spaced at the start of the test (4 measurements per second) and move further apart on a logarithmically decaying schedule as the test progresses. There are 40 measurements per log decade. This log type is commonly used for rapid step-drawdown pump tests, constant-rate pump tests, and slug tests.

Fast Linear

Fast Linear log type measures and records at a user-defined fixed interval of one minute or less. The interval is small (seconds, milliseconds), and the test is usually of short duration due to the volume of data logged and the impact of very fast sampling on battery life.

Step Linear

Step Linear log type measures and records data according to a number of user-defined elapsed time intervals or "steps" within a schedule. Both the elapsed time and the number of measurements within each step can vary. After completing the elapsed time for each step, the schedule will automatically move to the next step. Up to 10 separate steps can be defined.

About the Level Reference

A Level Reference, also called an offset, is a user-specified starting point for logged Level readings.

Depth mode does not require that you enter a Level Reference.

The Level Reference can be any value you choose. Here are some examples:

- **Elevation**—If you calculate the water level above mean sea level (MSL) and enter this as the Level Reference, then elevations above MSL will be logged.
- **Depth to Water**—If you measure the depth to the water surface (DTW) from the top of the well casing and enter this as the Level Reference, then DTW (also called drawdown) values will be logged.
- **Zero**—A Level Reference of 0 effectively sets the probe to zero at the start of the log. Changes, both positive and negative, from the starting water level, will be logged.

Once you have determined the value of your Level Reference, the software gives you three options for entering it. These control when the level reference is applied.

- **New Reference**—This option is designed to be used with an active software connection when the device is installed in the water.



A new level reference must be entered while the device's pressure sensor is submerged in its final position in the water. This is because the current probe reading is set equal to the Level Reference to create the offset that takes effect at the start of the data log. The log header will show the probe reading at the time you entered the Level Reference.

During log setup, the software presents two additional options for entering the Level Reference:

- **Set first logged reading**—Use this option when the instrument will be deployed on wire rather than cable because you will not be able to communicate with the instrument when it is submerged.
- **Remind me to set reference later**—Use this option to defer the entry of the Level Reference during log setup and set a reminder to enter it when the device is submerged in its final position.

Starting a Log

Every log is programmed for either a manual or a scheduled start. A log with a manual start time is displayed in the Logging screen with **Ready** in the **Status** column. A log with a scheduled start time is displayed with **Pending** in the **Status** column.

Starting a Pending Log

A **Pending** log automatically starts at the scheduled time without any user intervention.




A scheduled log with **Pending** status can be manually started at any time before its scheduled start.

Starting a Manual Log



With the instrument connected to the software, select the **Logging** tab.

Select the Ready log you want to start.


Click the **Start Log** button . The log starts and the symbol changes. The **Status** column displays **Running**.

Suspending (Pausing) a Log

A running log may be temporarily paused. For example, you might want to reposition an instrument, calibrate a sensor, or clean a sensor and later resume the log. A log can be suspended and resumed three times.

1. With the instrument connected to the software, select the **Logging** tab .
2. Select the log you intend to suspend.
3. Click the **Suspend** button . **Suspended** appears in the **Status** column.

Resuming a Suspended Log



1. To resume logging after a log has been suspended, select the **Logging** tab.
2. Select the **Suspended** log.
3. Click the **Start Log** button . Logging resumes. **Running** appears in the **Status** column. The data file will show the time when the log was suspended and the time when it restarted.

Stopping a Log

A log can be manually stopped at any time, even if a stop time has been previously scheduled. If you did not specify a stop condition when you defined the log, the log will run until the instrument is out of memory or battery power, or until you manually stop it.





A log that has been stopped cannot be resumed. If you intend to resume a log later, you should suspend a log rather than stop it.

1. To manually stop a log, the instrument must be connected to the software.
2. Select the **Logging** tab .
3. Select the running log you intend to stop.
4. Click the **Stop Log** button .

Downloading Data to a PC

This procedure copies the data log from the instrument to a PC. It does not remove the data log from the instrument. After a log is downloaded, it can be exported to a CSV file format that can be used by spreadsheet programs. The time shown in the log name is the time the log was downloaded.


1. With an instrument connected, select the **Logging** tab .
2. Select the log you intend to download.
3. Choose a Running, Suspended, Stopped, or Deleted log.
4. Click the **Download**  button.
5. In the next screen, select one of the three download options.
 - All data
 - New data (data logged since the last download)
 - Time interval to download



New data is downloaded by default to a new log file. To append new data to the last download of this log, be sure the option "Append logs on download" is selected in the **General Settings** dialog (**Preferences > General Settings**).

2. The log is copied to the connected PC into your Win-Situ working directory folder. View or change the working directory using **File > Settings**.
3. At the end of the download, Win-Situ gives you the option of viewing the data.
 - Select **Yes** and the log is displayed in the **Data** screen.
 - Select **No** and the **Logging** screen appears. You can view the data at any time by selecting it in the **Data** tab.

Viewing Logged Data

1. To view the data stored in the instrument, you must first download the data. A connection to an instrument is not needed after the data log has been downloaded.
2. Select the **Data** tab .

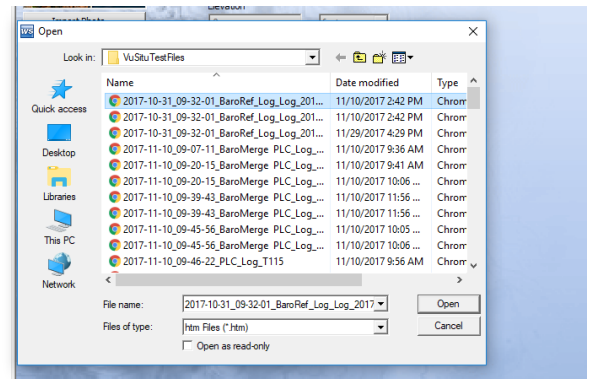
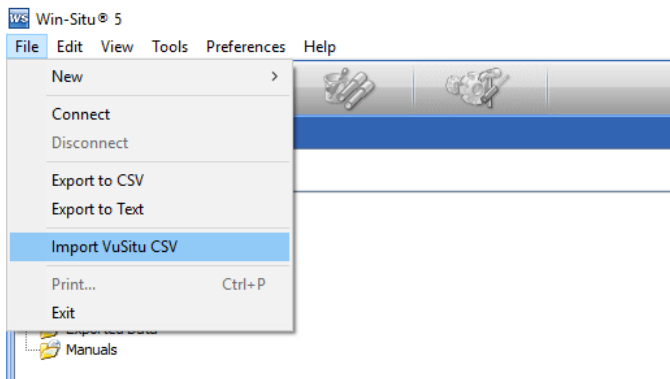
- On the left side of the screen, select the log you want to view. To expand a folder shown in the navigation tree, double-click the folder. The content of the data log is displayed on the right side of the screen in text or graph format.



To switch between view formats, click the **Text** or the **Graph** button in the control panel. To customize the text or graph view, select **Preferences > Graph Settings** or **Preferences > Data View Settings**. These options apply to all downloaded data until you change the options.

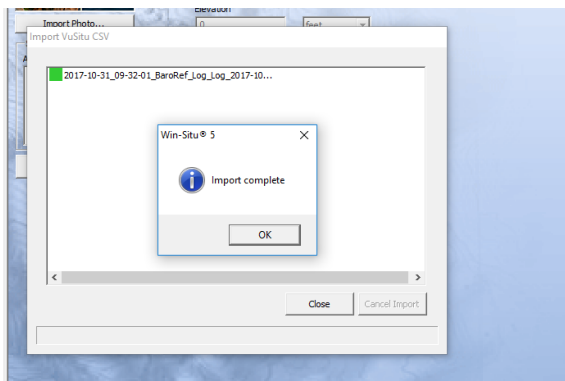
Importing VuSitu Data to Win-Situ

You can import data files from VuSitu into Win-Situ 5 from the File menu.

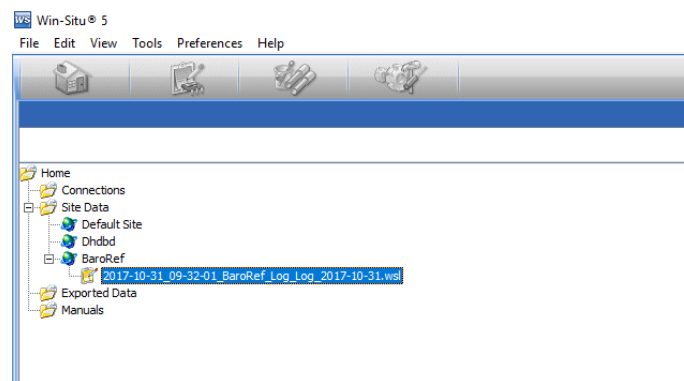


A. Click **File > Import VuSitu CSV** in the menu bar at the top of the screen.

B. Select the file you wish to import and click **Open**.



C. Select **OK** at the prompt.



D. Click on the file name to view it.

Using BaroMerge Software

BaroMerge Software is used to post-correct absolute (non-vented) level sensor data to eliminate barometric pressure effects from the measurements. BaroMerge Software can be accessed through the Win-Situ 5 Software **Tools** menu. BaroMerge provides three options to correct data.

- **Fixed Correction**—A single offset value is applied to all selected log data. Use this option if you know the barometric pressure of the site during the log, and know that it did not change.
- **Manual Entry**—Specify two or more correction values to apply to the log data. Use this option if you wish to manually enter a data set of barometric pressure values.
- **BaroTROLL log file**—Absolute level sensor data points are individually corrected to reflect barometric pressure changes that were logged by a BaroTROLL instrument during the approximate time period.



BaroMerge Input—BaroTROLL File

Log files that contain absolute data can be barometrically compensated using values logged by the In-Situ Inc. BaroTROLL Instrument. Select this method when you have access to a BaroTROLL log file covering approximately the same time period as the data file you intend to correct.

To use this correction method, you need the name of the BaroTROLL log file and the name(s) of the absolute log file(s) you want to correct.

1. From the **Tools** menu in Win-Situ 5 Software, select **Win-Situ BaroMerge**.




2. Select the "Use a BaroTROLL file:" option.
3. Click the browse button to the right of the file field.
4. Select a BaroTROLL file and click the **check mark**.
5. Values from the BaroTROLL file will be displayed in the next window. You can edit these values if necessary.
6. Click the **right arrow** button.
7. Select the log file(s) you intend to correct and click the **check mark**.
8. Compensated data files can be viewed or exported from the **Data** tab.

BaroMerge Output

Your original log file is not changed. A new, corrected log file with the same name and path is created. The original ".wsl" extension is replaced by "-Baro Merge.wsl".

Disconnecting an Instrument from the Software

Click the plug icon  in the lower-right corner of the screen to disconnect the instrument from the software. Disconnect the instrument from the communication device. Attach a desiccant pack if you are using a vented cable.

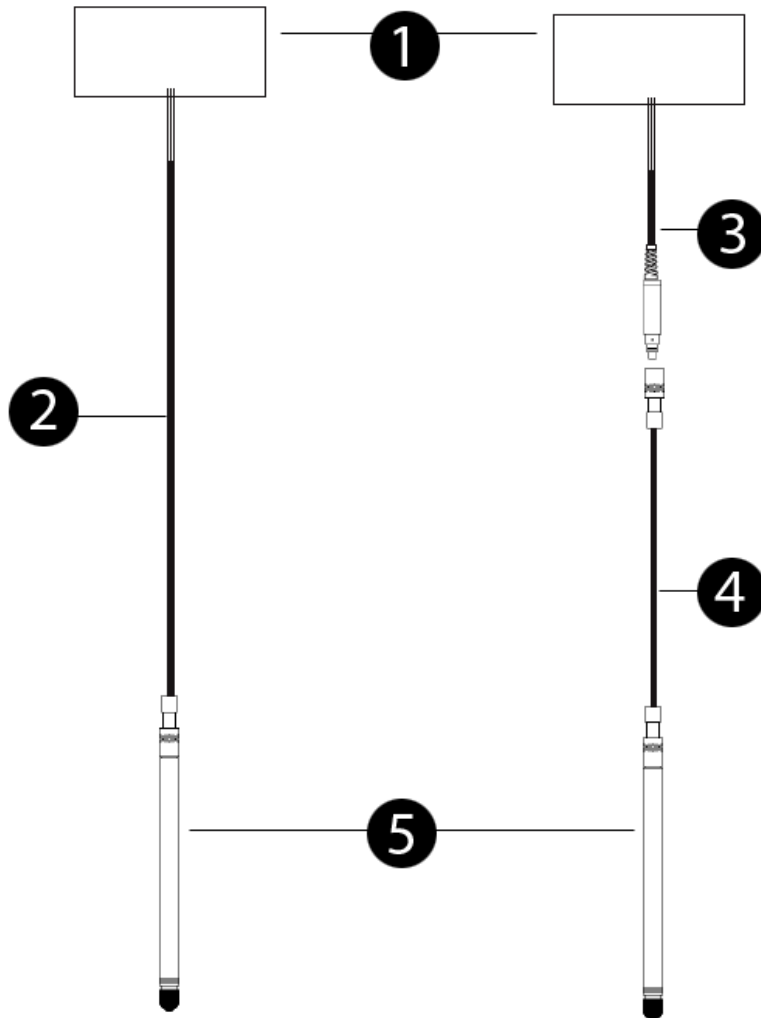
Connect to a Data Logger or PLC Controller

The instrument can be connected to a data logger or controller via a stripped-and-tinned RuggedCable System for communication using one of the following protocols.

- Analog (4-20 mA)
- SDI-12
- RS485 Modbus
- RS232 Modbus (with a customer-supplied converter)

Stripped-and-tinned RuggedCable System includes a female connector on one end that connects to the instrument. The uphole end terminates in stripped-and-tinned wires for connection to a PLC controller or data logger.

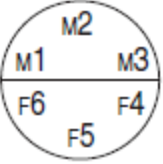
A shorter length Stripped-and-tinned RuggedCable System with a male connector is available to convert a female to female RuggedCable System to a stripped-and-tinned configuration.



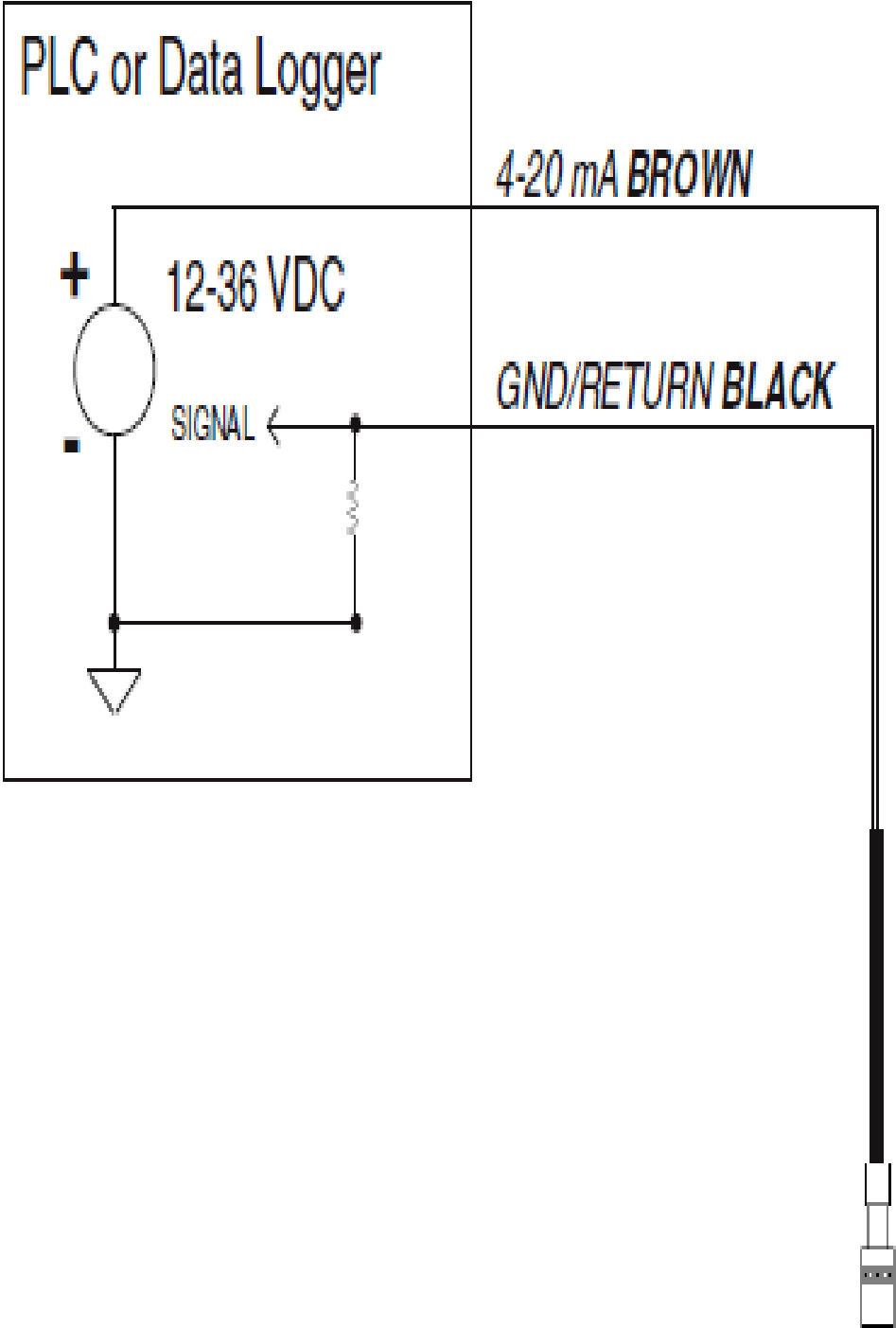
1	PLC or Data Logger
2	Stripped-and-tinned RuggedCable System with female connector
3	Short stripped-and-tinned RuggedCable System with male connector
4	RuggedCable System with female to female twist-lock connector
5	Instrument

Wiring

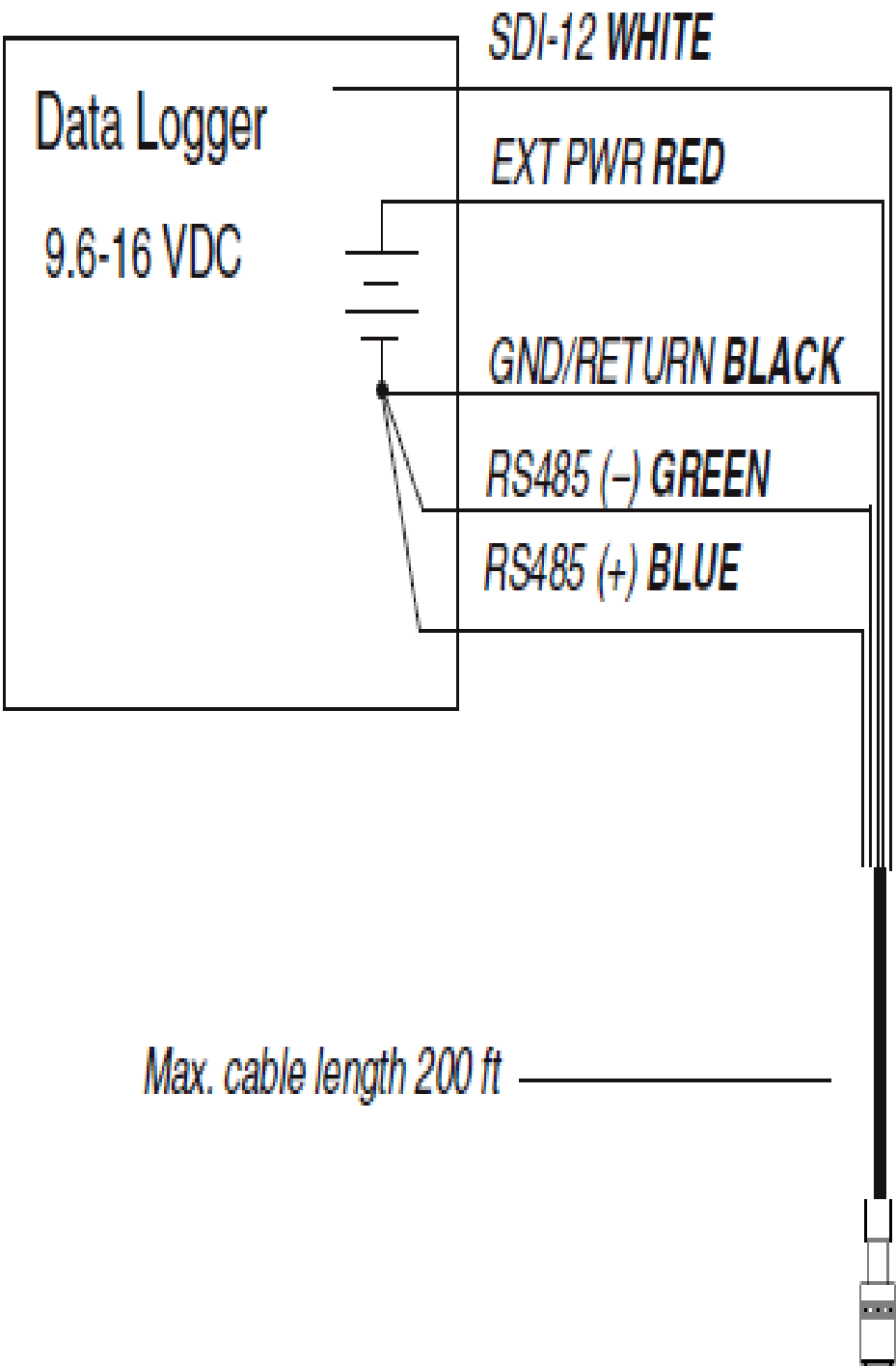
Refer to the diagrams on the following pages for wiring information. Make sure that you trim and insulate unused wires. The shield must be wired to a chassis ground or earth ground.

Signal	Color	Pin	
Gnd/Return	Black	6	
Ext Power	Red	5	
4-20 mA	Brown	4	
RS485(-)	Green	3	
RS485(+)	Blue	2	
SDI-12	White	1	

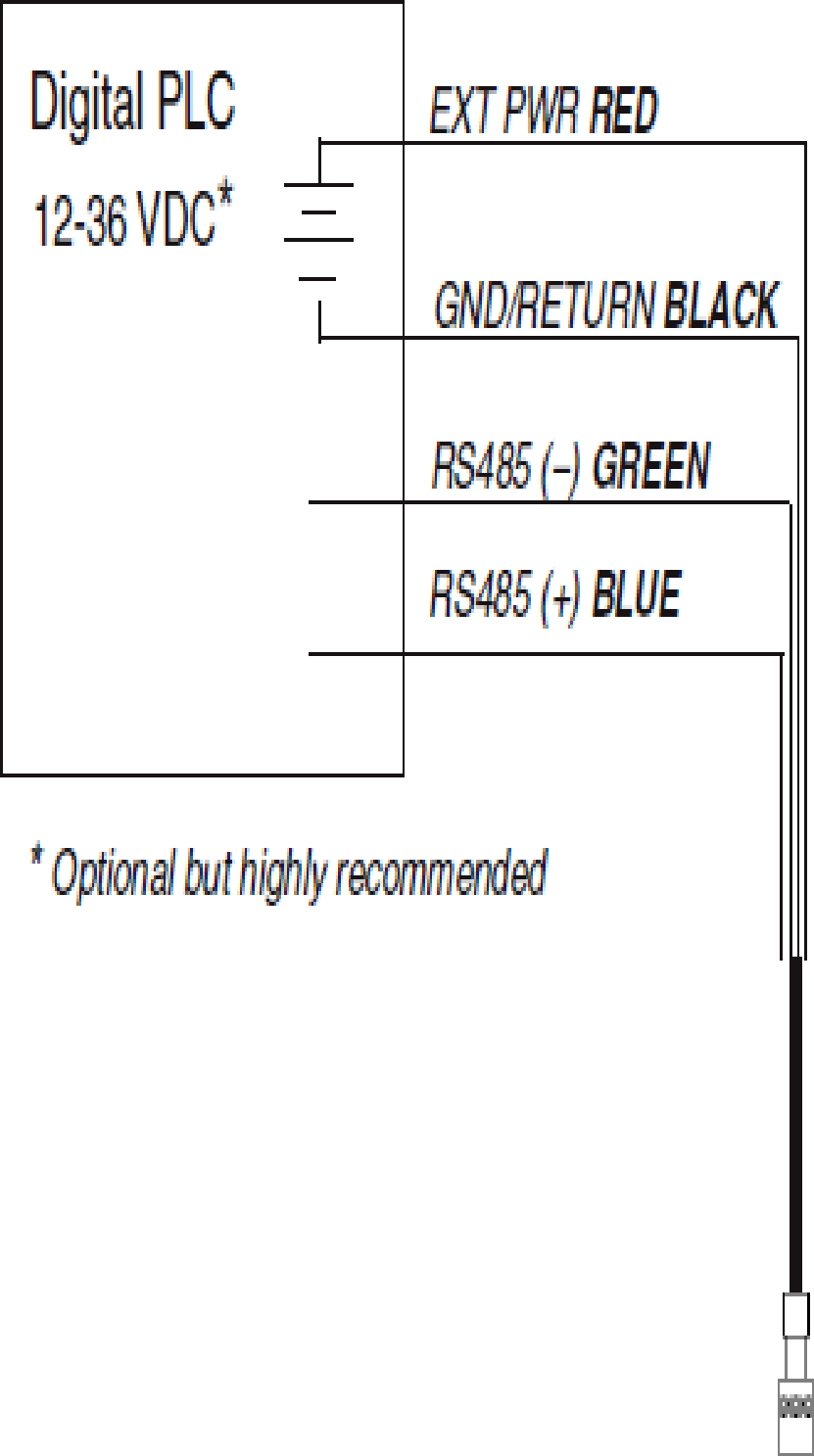
Analog (4-20 mA) 2 Wire



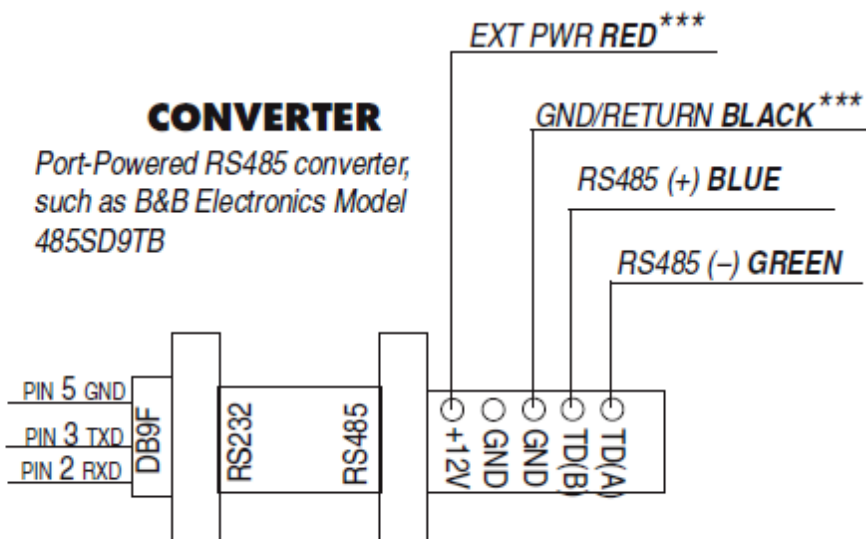
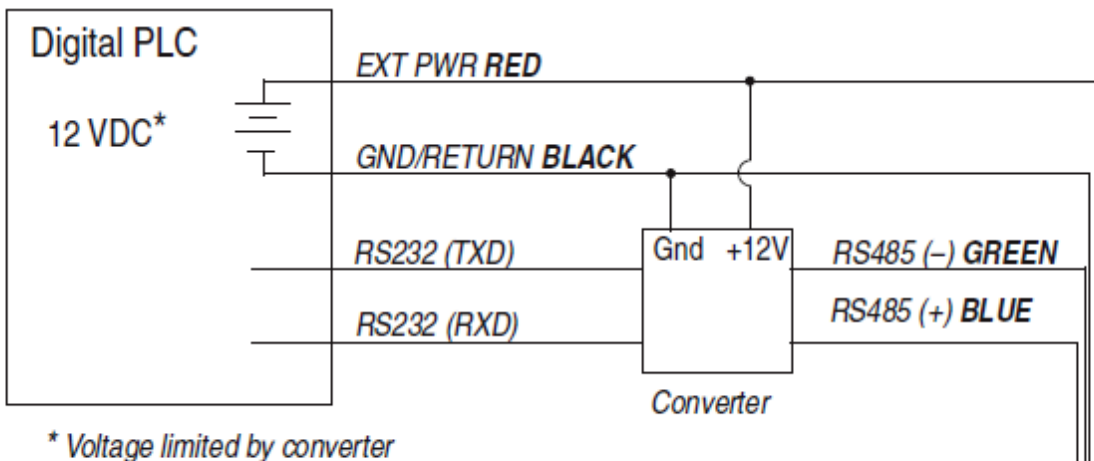
SDI-12 3 Wire



Modbus Master



Modbus Master with RS232 (Converter Required)



***Required if port power is not available

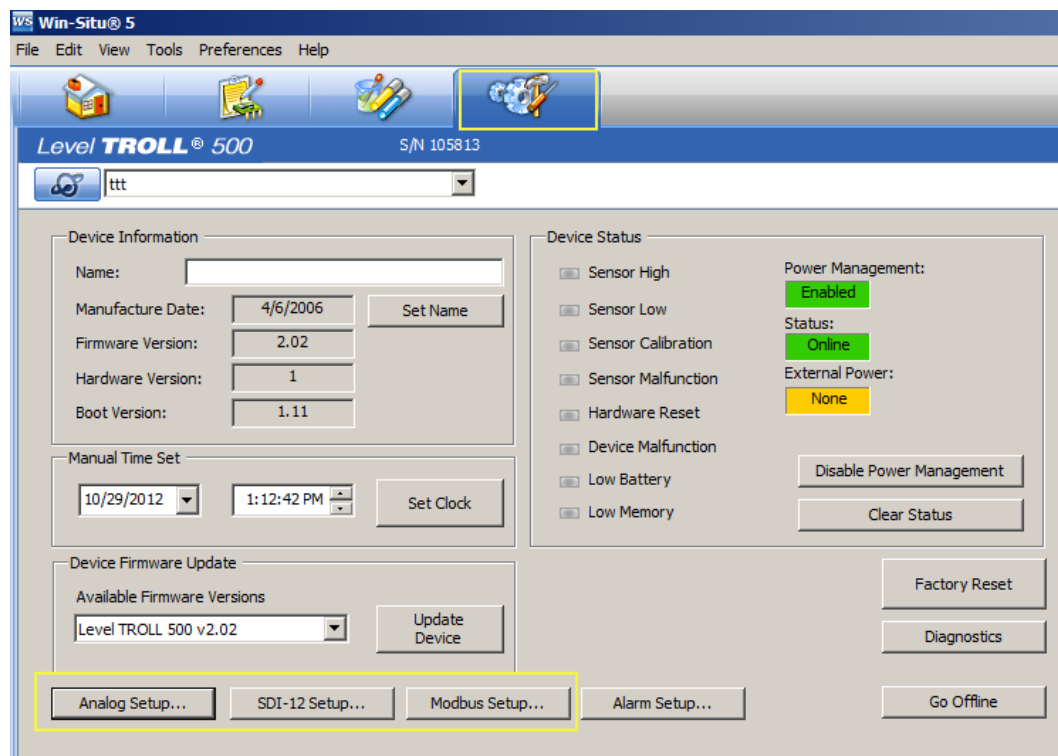
Power Connections

The Red wire provides power for Modbus and SDI-12 modes. The Brown wire provides power for the 4-20 mA mode. If power is present on the Brown wire and not on the Red wire, the device enters the 4-20 mA mode automatically and stays in the 4-20 mode until power is removed from the Brown wire or is applied to the Red wire. The Red wire has priority. If power is applied to the Red and Brown wires at the same time, the device will operate in Modbus or SDI-12 modes but not in 4-20.

Communication Protocols

The device automatically switches between Modbus and SDI-12 modes depending on which of the two interfaces has activity. Modbus and SDI-12 cannot be used at the same time. The communication protocol that is currently in use will block communication on the other.

Win-Situ 5 Software provides options for configuring analog/SDI-12 communications and Modbus communications on the **Tools** tab.



For additional information on Modbus and SDI-12 communications, including the SDI-12 commands and Modbus registers, see www.in-situ.com/Technical_notes and scroll to the Communications and Software Technical Notes section.

Redundant Logging

The instrument is capable of internal logging while participating in a Modbus, SDI-12 or analog network. However, Win-Situ 5 Software cannot communicate with the instrument while it is transmitting Modbus, SDI-12, or 4-20 mA analog data, and the instrument cannot receive or respond to Modbus, SDI-12, or 4-20 mA analog commands while connected to a PC serial port.

If the PLC or data logger loses data, the data that was logged internally on the instrument can be retrieved using Win-Situ 5 Software.

If the PLC or data logger experiences power loss, the instrument will continue to collect data using its internal batteries and clock.

A port-powered RS485 converter like that shown for Modbus connections may be used for temporary connection of the Level TROLL to a serial port on a PC.

Cleaning and Maintenance

Overview

It is important for users to perform scheduled maintenance on their instruments to sustain the accuracy and longevity of the probes and cables. The frequency of this maintenance depends on the characteristics of the deployment site, including humidity levels and the degree of fouling.

Users should be aware of the conditions at their deployment sites and develop appropriate maintenance schedules to replace desiccant, clean the instruments, and send in the instruments for factory calibration. Users should check instruments often during the first portion of the deployment to determine the frequency of maintenance. General maintenance should be performed as often as possible. Factory maintenance and calibration should be performed every 12 to 18 months.

Operating Considerations

The instrument has been designed to withstand harsh field conditions. However, as with any electronic instrument, it can be permanently damaged if used outside its operating specifications.

Temperature

Review the instrument specifications to determine the operating range. Do not deploy instruments in such a way that ice may form on or near the sensors or cable connections. Ice formation is a powerful expansive force that can over-pressurize the sensor or otherwise cause damage that is not covered by the warranty.

Pressure Range

The instrument can withstand pressures of up to two times (2X) the rated range of the pressure sensor without damage, although it may not read correctly at such pressure. If the pressure range is exceeded by 3X, the sensor will be destroyed.

Batteries

Internal batteries in the instrument are not user-replaceable. The approximate percentage remaining is displayed in Win-Situ software or the Vu-Situ mobile app when the instrument is connected.

If batteries are completely exhausted, external power and battery pack options are available. See page 24.

Desiccant Pack Options

Small Desiccant

The Small Desiccant is a disposable cap that ships with In-Situ products. The small desiccant is meant to protect the instrument and cable **only during shipping and should not be used for deployments**.



Large and Extra Large Desiccant

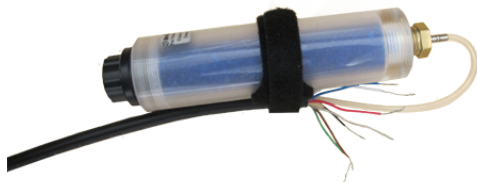
The Large and Extra-Large Desiccant are used to protect equipment deployed in the field. The Large Desiccant is best suited for low-humidity environments or deployments where maintenance occurs regularly. The Extra-Large Desiccant is designed for high-humidity environments or deployments where maintenance occurs infrequently. Extra-Large Desiccants provide six times the drying capability of the Large Desiccant. When the desiccant expires, both can be refilled with fresh desiccant and re-used (see Desiccant Refill Kit below). The Large Desiccant is available with an ABS or a titanium twist-lock connector, while the Extra Large Desiccant uses a titanium connector only.



Description	Part Number
Large Desiccant, Titanium	0051810
Large Desiccant, ABS	0053550
Extra Large Desiccant	0090420

Outboard Desiccant

The Outboard Desiccant is a replaceable desiccant pack designed to attach to the vent tube of a stripped-and-tinned cable.



Description	Part Number
Outboard Desiccant	0051380

Desiccant Refill Kit

The Desiccant Refill Kit supplies desiccant for the Large Desiccant, Extra Large Desiccant, and the Outboard Desiccant. It also contains replacement glass wool.

Description	Part Number
Desiccant Refill Kit	0029140

Installing Desiccant with Twist-Lock Connectors

1. Remove the protective dust cap from the bottom of the desiccant pack, if applicable.
2. Remove expiring desiccant (if present) from the cable by grasping the textured section of the cable connector in one hand and the desiccant in the other. Twist in opposite directions to unlock the desiccant from the cable.
3. Attach the new desiccant pack to the twist-lock connector on the cable.



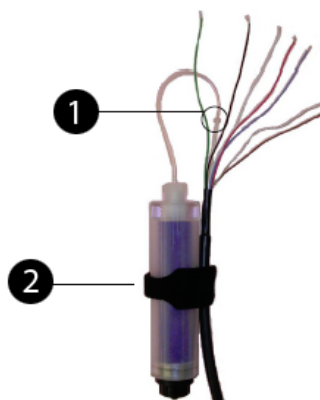
Installing Outboard Desiccant

Vented cable must be installed with outboard desiccant to protect the cable and instrument electronics from condensation in high-humidity environments.

The desiccant can be removed from the vent tube, if necessary, to trim the conductor wires. However, you must reinstall the desiccant after trimming and connecting the wires.

1. Cut off the knot at the bottom of the vent tube extension.
2. Firmly attach the vent tube extension to the cable vent tube. Cover at least 6.4 mm (0.25 in.) of the cable vent tube for a secure attachment.
3. Use the attached hook-and-loop strap to secure the desiccant to the cable, below the stripped wires.

4. Remove the red dust cap from the black nylon cap to allow air to reach the cable's vent tube.



1	Outboard desiccant is attached to the cable vent tube.
2	Desiccant is secured to the cable with a strap.

Using the Desiccant Refill Kit

1. Remove the black nylon vent cap from the top of the desiccant.
2. Pour out and discard the used desiccant. Check the glass wool in the bottom of the container and replace if necessary.



The glass wool prevents the desiccant beads from falling out the cable end of the desiccant pack. If the wool glass does this effectively, there is no need to replace it when refilling the desiccant.

3. Fill the container with fresh desiccant. Replace the vent cap. Reattach to cable if removed.

Antifouling

TROLL Shield Nose Cone

The copper TROLL Shield Nose Cone is designed to reduce macro- and micro-fouling of the pressure sensor on Level TROLL and Aqua TROLL Instruments. Reduced fouling on the sensor improves measurement accuracy and extends the length of deployments.

For optimum performance, the TROLL Shield Nose Cone should be replaced every 12 months or sooner if site conditions are extremely harsh.



Description	Part Number
TROLL Shield Nose Cone	0081480

O-ring Inspection and Replacement

Examine O-rings for wear, dryness, discoloration, stretching, cracks, nicks, and brittleness. Replace O-rings when any of these conditions are present. Replacing O-rings on an annual basis, regardless of their condition, is the best way to protect against moisture damage.

Perform the following steps to replace an O-ring.

1. Remove and discard the damaged O-ring.
2. Use a clean, dry, soft cloth to clean the O-ring groove to remove dirt or residue.
3. Lubricate the new O-ring using high-vacuum grease.
 - a. Wash your hands thoroughly.
 - b. Apply a small amount of grease to the pad of your index finger, and rub your index finger and thumb together to spread the grease evenly.
 - c. Inspect the new O-ring and remove any debris stuck to it.
 - d. Rub your fingers around the O-ring until there is a thin layer of grease on the entire O-ring.
4. Install the O-ring in the groove and remove any excess lubricant with a clean cloth.

Do not allow water or lubricant to enter the connector.

Cleaning and Storage

Cleaning the Instrument

Clean the instrument body with water and a soft brush or plastic scouring pad, or soak overnight in a mild acidic solution, such as household vinegar. **NEVER** submerge the connector portion of the instrument when it is not connected to a cable.

If the ports near the pressure sensor are clogged with silt or mud, try the following procedures.

- Agitate the instrument vigorously in a bucket of clean water.
- Apply a gentle rinse of water from a wash bottle.
- In severe cases, remove the nose cone and clean out the holes with a soft brush or pipe cleaner.

Do not attempt to remove material from the instrument by tapping the instrument against a surface. To avoid damage to the pressure sensor diaphragm, do not insert any object into the sensor opening or attempt to dig out dirt or other materials. **You void the instrument's warranty by inserting anything into the sensor opening.** If contamination cannot be removed using the recommendations above, please contact In-Situ for cleaning.



*A TROLL pressure sensor with the nose cone removed. Do not insert **ANY** object into the sensor opening. Doing so voids the warranty.*

Twist-Lock Connectors

Keep the pins on all connectors free of dirt and moisture by using the soft protective dust caps when cable is not attached.

Storage

Store the instrument in a clean, dry place. Place the protective red dust cap on the cable end or store with cable attached to protect the connector pins and O-ring. For vented cables, ensure the desiccant used is the appropriate size and change it when needed. Store the instrument where it will not roll off a bench onto a hard surface or sustain other mechanical shock. Protect the instrument from temperature extremes using the following guidelines:

- Level TROLL Instruments—store within the temperature range -40° C to +80° C (-40° F to +176° F)

Factory Calibration and Service

In-House Factory Calibration

Factory calibration of In-Situ instruments should be performed every 12 to 18 months, or at any point when the data appears to drift significantly. Factory calibration includes a thorough cleaning, all operational checks, necessary firmware upgrades, O-ring replacement, and full range calibrations of the pressure sensor, temperature sensor, and conductivity sensor (when applicable).

Return Materials Authorization (RMA) Form

To obtain a factory calibration, fill out and return the online Return Materials Authorization (RMA) form located at www.in-situ.com/.

Obtaining Repair Service

If you suspect your system is malfunctioning and repair is needed, you can help assure efficient servicing by following these guidelines:

1. Call or email In-Situ Technical Support. Have the product model and serial number available.
2. Be prepared to describe the problem, including how the product was used and the conditions noted at the time of the malfunction.
3. If Technical Support determines that service is needed, they will ask your company to fill out the RMA form and pre-approve a specified monetary amount for repair charges. When the form and pre-approval is received, Technical Support will assign an RMA (Return Material Authorization) number.
4. Clean the product as described in the manual.
5. If the product contains a removable battery, remove and retain it unless you are returning the system for a refund or Technical Support states otherwise.
6. Carefully pack your product in its original shipping box, if possible.
7. Mark the RMA number clearly on the outside of the box.
8. Send the package, shipping prepaid, to:

In-Situ
ATTN: Repairs
221 East Lincoln Avenue
Fort Collins, CO 80524

The warranty does not cover damage during transit. In-Situ recommends insurance for all shipments. Warranty repairs will be shipped back prepaid.

Outside the U.S.

Contact your international In-Situ distributor for repair and service information.

Guidelines for Cleaning Returned Equipment

Please help us protect the health and safety of our employees by cleaning and decontaminating equipment that has been subjected to potential biological or health hazards, and labeling such equipment. Unfortunately, we cannot service your equipment without such notification. Please complete and sign the form on page 78 (or a similar statement certifying that the equipment has been cleaned and decontaminated) and send it to us with each instrument.

- We recommend the glassware cleaning product, Alconox, available from In-Situ and from laboratory supply companies.
- Clean all cables and remove all foreign matter.
- Clean the cable connectors with a clean, dry cloth. Do not submerge the connectors.
- Clean the instrument including the nosecone, cable head, and protective caps.



If an instrument is returned to our Service Center for repair or recalibration without a statement that it has been cleaned and decontaminated, or if it is the opinion of our Service Representatives that the equipment presents a potential health or biological hazard, we reserve the right to withhold service until proper certification is obtained.

Decontamination and Cleaning Form

Decontamination & Cleaning Statement

Company Name _____ Phone _____

Address _____

City _____ State _____ Zip _____

Instrument Type _____ Serial Number _____

Contaminant(s) (if known) _____

Decontamination procedure(s) used _____

Cleaning verified by _____ Title _____

Date _____



Troubleshooting

In addition to the following troubleshooting items, the In-Situ website includes instructional videos, technical notes, and more. See www.in-situ.com/.

Problem	Possible Cause	Possible Solution
Win-Situ 5 Software cannot connect to the instrument.	Wrong COM port is selected, communication settings are incompatible, cable connections are loose or dirty, or batteries are low.	<p>Make sure cable connections are tight and connectors are clean and dry.</p> <p>Make sure the cable is securely attached to the instrument.</p> <p>Make sure the correct COM port is selected (select Preferences > Comm Settings to verify).</p> <p>Make sure the communication settings in Win-Situ and in the instrument match. To reset the device communication settings to the serial defaults, click "Reset all Devices" in the Comm Settings dialog (Preferences > Comm Settings).</p> <p>Make sure the internal battery has voltage remaining, or external power is supplied.</p> <p>See www.in-situ.com/Technical_notes and scroll to the Communications and Software Technical Notes section for more information.</p>
Real-time readings display the wrong units.	Default units are being used.	Click the Sensors tab, select the sensor, click the configure button and select the desired units for each parameter in the Sensor Setup window.
Cannot add a new log.	<p>Only one active log can reside in the device at a time—an active log is a log that is Ready, Pending, Running, or Suspended as shown in the Status column of the Logging Tab.</p> <p>The device has its maximum number of logs already stored—the Level TROLL 300, 500, and Baro TROLL have a capacity of 2 logs.</p>	<p>Stop or delete the log if possible. Alternatively, configure the new log after the active log is completed.</p> <p>Download, and then delete a log you no longer need. This will make room for an additional log on the device.</p>
New log exceeds available memory (software message).	The log as configured would exceed the device memory.	<p>Edit the log and select a longer sampling interval.</p> <p>If available, select the "wrap data" option. This causes more recent data to overwrite older data when memory is full.</p> <p>For a log with a scheduled start, select None as the stop condition, or select a stop time that is closer to the start time.</p>

Problem	Possible Cause	Possible Solution
Cannot configure level or other parameters using the Configure button on the Sensors tab. The Sensor Setup screen is shown, but the Configure... button is dim.	<p>The instrument is actively polling (continually updating real-time readings) in the Home tab.</p> <p>The instrument has an active log—a log that is Ready, Pending, Running, or Suspended as shown in the Status column of the Logging tab. Only one active log can reside in the device at a time.</p>	<p>Return to the Home tab and stop real-time readings by clicking the Play button.</p> <p>Stop or delete the log if possible. Alternatively, configure parameters after the log is complete.</p>

Declarations of Conformity and Similarity

Level TROLL 400 Instrument

EMC Verification Declaration of Similarity

Equipment

Type of equipment:	Measurement instrumentation
Product name:	Level TROLL® 400
Model:	Level TROLL® 400

Manufacturer:	In-Situ, Inc. 221 East Lincoln Avenue Fort Collins, CO 80524 USA
---------------	---

Category

Standards

Emission:	EN 61326 & FCC Part 15, Subpart B
-----------	-----------------------------------

Immunity:	EN61326
-----------	---------

Summary

We confirm that the equipment referenced above, without reasonable doubt, will fulfill the requirements concerning electromagnetic compatibility according to the above mentioned standards harmonized with the EMC Directive 89/336/EEC. The Level TROLL 700 was tested and found to be in compliance in the month of January 2006.

Date of Issue:	August 30, 2013
----------------	-----------------



Ben Kimbell
Vice President of Research and Development

Level TROLL 500 Instrument

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Model: Level TROLL 500
Product Description: The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directives:

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use
- **Emissions**
Class A requirements of EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:

The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.



Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006



Level TROLL 700 Instrument

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Model: Level TROLL 700
Product Description: The Level TROLL measures and logs level and temperature in natural groundwater and surface water.

is in compliance with the following Directives:

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use
- **Emissions**
Class A requirements of EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:

The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.



Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006



TROLL Com Communication Device

Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: TROLL Com
Model: USB TROLL Com
Product Description: RS485 to USB converter

is in compliance with the following Directive

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
EN 61326, Electrical Equipment for Measurement, Control and Laboratory Use, Industrial Location
- **Emissions**
Class A requirements of EN 61326, Electrical Equipment for Measurement, Control and Laboratory Use

Supplementary Information:

The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.



Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
June 17, 2006



Declaration of Conformity

Manufacturer: In-Situ, Inc.
221 East Lincoln Avenue
Fort Collins, CO 80524
USA

Declares that the following product:

Product name: Level TROLL
Product name: Baro TROLL
Product Description: The Baro TROLL measures and logs barometric pressure and temperature.

is in compliance with the following Directives:

89/336/EEC for Electromagnetic Compatibility (EMC) Directive
73/23/EEC for Safety Directive

and meets or exceeds the following international requirements and compliance standards:

- **Immunity**
EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use
- **Emissions**
Class A requirements of EN 61326:1997, Electric Equipment for Measurement, Control and Laboratory Use

Supplementary Information:

The device complies with the requirements of the EU Directives 89/336/EEC and 73/23/EEC, and the CE mark is affixed accordingly.



Todd Campbell
New Product Development Program Manager
In-Situ, Inc.
January 17, 2006





OPERATION MANUAL

JEROME® J505 MERCURY VAPOR ANALYZER

December 2015

Firmware v1.1X

ARIZONA INSTRUMENT LLC

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MADE IN THE USA

AZI P/N 700-0130-F
Last update December 2015

JEROME® J505

Mercury Vapor Analyzer

Operation Manual



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All section numbers, titles and page numbers in **BOLD** in this manual are hyperlinks and can be clicked to simplify navigation within the PDF version of the manual. The BACK button found in most PDF software programs is also very helpful when navigating using the hyperlinks.

An up-to-date electronic copy of this manual can be found at www.azic.com

Call AZI Customer Service at (800) 528-7411 or (602) 470-1414 if you have any questions.
If you prefer, you may send e-mail to support@azic.com

1. UNPACKING THE INSTRUMENT

This manual contains details that will optimize the results and the life of your instrument. Read and refer to the manual for complete details on operation, maintenance and troubleshooting, and data output.

The Jerome® J505 is easy to operate and ready for use upon receipt from the factory.

- Remove the instrument from the packing material.



Retain all packaging materials for any future shipment of the instrument. If the instrument is returned to AZI for any reason, it must be placed in the original packaging materials that have been tested and proven to be effective protection during shipment.

- Check for any damage and confirm receipt of all parts on your packing list. Contact Arizona Instrument Customer Service at (800) 528-7411 or (602) 470-1414 if you have any questions.
- The included 12VDC power adapter utilizes 100 to 240VAC, 50-60 Hz.

2. WARNINGS & REPACKING

- The instrument is designed for ambient air monitoring.



**The J505 is for non-condensing gaseous vapor use only.
DO NOT expose the probe or instrument's intake
to any liquid, dust, or other foreign material.
DO NOT obstruct the intake port, as this could cause reading
errors and damage to the flow control system.**

- The instrument's light source contains a small amount of elemental mercury. Call or email AZI Customer Service for a copy of the MSDS or for other questions.
- To maximize the life of the light source, turn off the instrument when it will not be used for an extended period of time.
- In case of emergency or instrument failure, disconnect the instrument from the power supply.
- If the instrument is not used as specified by the manufacturer, then protection provided by the instrument may be impaired.
- The instrument is not explosion proof.
- Call AZI Customer Service at 800-528-7411 or 602-470-1414 or go to the AZI website www.azic.com for Return Material Authorization (RMA) information prior to returning a unit.
- Boxes and packing materials for all shipments are available from AZI.
- Pack the instrument only in a Jerome® shipping container.



**AZI WILL NOT BE RESPONSIBLE FOR SHIPPING DAMAGE.
IF YOU RETURN THE INSTRUMENT IMPROPERLY PACKAGED OR
SHIPPED, YOU SHOULD INSURE IT FOR FULL VALUE.**

3. INTRODUCTION

The Jerome® J505 Mercury Vapor Analyzer is an ambient air analyzer with a range of 0.05 to 500 micrograms of mercury vapor per cubic meter ($\mu\text{g}/\text{m}^3$ Hg). The instrument uses atomic fluorescence spectroscopy for mercury analysis, which allows the detection cell to be simpler, smaller, more durable and lighter weight than competing spectroscopy instruments. A smaller optical cell also requires less flow to purge the system, allowing the J505 to run at a lower flow rate than competing spectroscopy instruments. A low flow rate is essential for accurate low-level mercury detection because higher flow reduces the ability to pinpoint the source and dilutes the sample stream, negatively affecting instrument accuracy.



CAUTION

**The J505 is for non-condensing gaseous vapor use only.
DO NOT expose the probe or instrument's intake
to any liquid, dust, or other foreign material.**

The J505 is designed for easy operation for quick and accurate analysis of mercury vapor levels. It has few maintenance requirements. However, please take a moment to read this manual before operating the instrument. If you have any questions about your application or operation, please call AZI Customer Service at (800) 528-7411 or (602) 470-1414 or e-mail support@azic.com for assistance.

Features

- Lower detection levels than the previous generation analyzers.
 - Resolution is $0.01\mu\text{g}/\text{m}^3$ ($10\text{ng}/\text{m}^3$) in Standard test mode.
- 3 test modes:
 - Standard for normal sampling or detection of EPA or ATSDR cleanup levels,
 - Quick for faster sampling, and
 - Search for scanning an area to locate the source of contamination.
 - Test mode is easily selected from the Main screen with the MODE softkey.
- Choice of measuring units for results:
 - Nanograms per cubic meter (ng/m^3),
 - Micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), or
 - Milligrams per cubic meter (mg/m^3).
 - Measuring units are easily selected from the Main screen with the UNITS softkey.
- 3.5 inch (9 cm) color LCD display.
 - High brightness backlight for easier readability.
 - Readings are in 1/4 inch (6 cm) tall font for easy readout.
 - Main display shows sample value, date and time, USB status, battery life, charging status, current test site, and user selected test mode and units.
- User interface includes easy to use menu system.

- Integrated data logging stores all test results (except in Search mode).
 - Stored test results are easily viewed on the display screen with their test site.
 - Average value and standard deviation can be computed on a user-selectable range of results.
 - A range of results can be saved to a USB flash drive in a comma-delimited format for easy import into Microsoft Excel[®].
- Each test result can be identified with a test site.
 - Test sites are user programmable. The active test site is selected from a list, and a list of predetermined sites can be entered and easily reused.
 - An optional USB keyboard can be used for menu navigation and text entry. The F1-F4 keys on the keyboard can operate the softkeys on the instrument.
- Unattended Autosample at intervals from 1 to 120 minutes.
- Two user programmable alarm levels.
 - When a programmed alarm level is exceeded, an audible alarm sounds, the test result is displayed in red, and test records saved to the USB flash drive are tagged with “ALARM.”
- Battery operation for 10 or more hours.
 - Charging time is 3 hours for a fully discharged battery.
 - Charge the battery at room temperature ($\leq 30\text{ }^{\circ}\text{C}$ or $86\text{ }^{\circ}\text{F}$) for optimum performance.
 - 12VDC power adapter utilizes 100 to 240VAC, 50-60 Hz.

Applications

- Regulatory detection compliance
- Regulatory cleanup compliance
- Ambient air analysis
- Quality control
- Scrubber efficiency testing
- Accuracy check for other mercury vapor monitors and control systems
- Mercury vapor source detection
- Leak detection

4. TECHNICAL SPECIFICATIONS

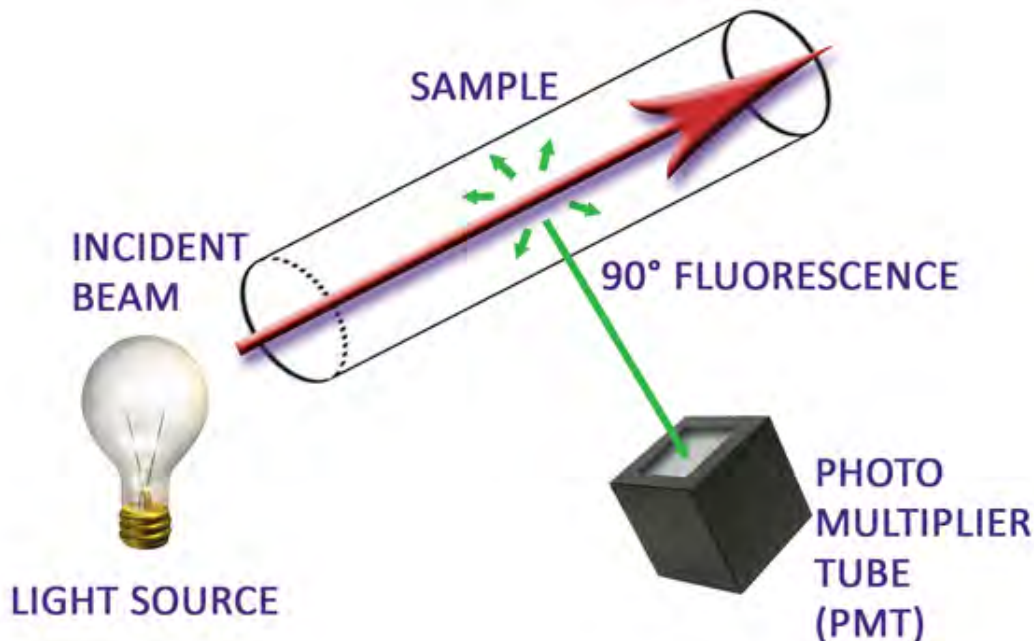
Test Mode	Units:	ng/m ³	µg/m ³	mg/m ³
Standard	Range	50 to 500,000	.05 to 500	0.00005 to 0.50000
	Resolution	10	0.01	0.00001
Quick	Range	100 to 500,000	0.1 to 500	0.0001 to 0.500
	Resolution	100	0.1	0.0001
Search	Range	100 to 500,000	0.1 to 500	0.0001 to 0.500
	Resolution	100	0.1	0.0001
Typical Test Time	Standard	28 seconds		
	Quick	16 seconds		
	Search	8 seconds for first reading then continuous 1 second updates		
Power requirements		Internal battery (NiMH) with 10+ hours of operation 12VDC power adapter runs on 100-240VAC, 0.8A, 50-60Hz Battery charges in 3 hours or less Charge the battery at room temperature ($\leq 30\text{ }^{\circ}\text{C}$ or $86\text{ }^{\circ}\text{F}$) for optimum performance. (Note: Battery will not charge if battery temperature $> 40\text{ }^{\circ}\text{C}$)		
Operating environment		5 to $45\text{ }^{\circ}\text{C}$, non-condensing, non-explosive		
Dimensions		12in L x 6.2in W x 8.4in H (30.5cm L x 15.7cm W x 21.3cm H)		
Weight		6.5 pounds (3.0 kilograms)		
Display		3.5 inch (9 cm) color LCD display. High brightness backlight		
Unattended Autosample		Available in intervals of 1, 2, 5, 10, 15, 20, 30, 45, 60, 90 or 120 minutes		
Data storage capacity		Up to 10,000 test results 100 test sites		
USB		USB port located on rear of instrument Test results and calculations saved to USB flash drive Menu navigation, text entry, and softkey operation with optional USB Keyboard		
Certifications		UL Listing: 61010, CE		

Accuracy and Precision (Standard mode):

Gas Level	Accuracy	Precision (RSD)
0.3 µg/m ³	± 15%	15%
1 µg/m ³	± 10%	7%
25 µg/m ³	± 10%	5%
100 µg/m ³	± 10%	3%

5. PRINCIPLE OF OPERATION

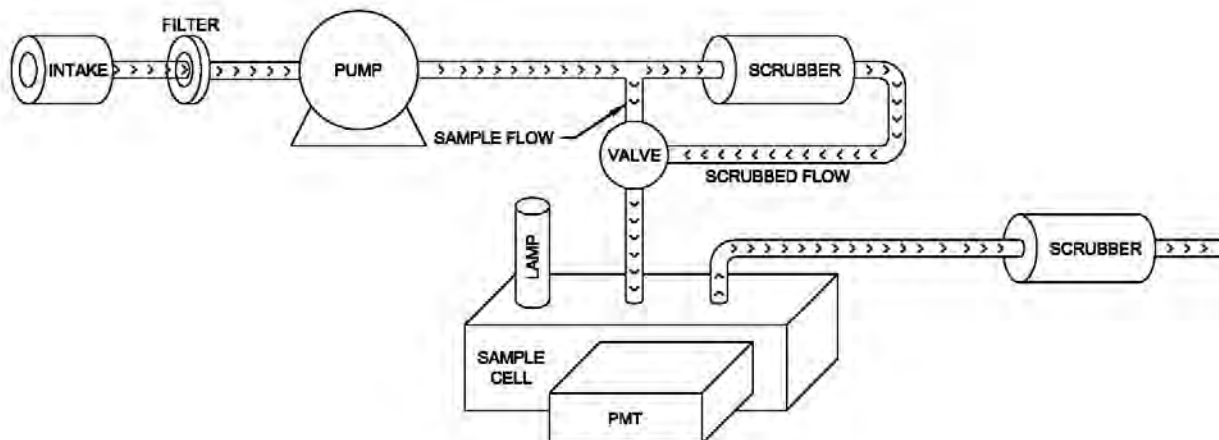
The J505 uses atomic fluorescence spectroscopy for mercury analysis. As shown below, a mercury light source is energized to emit light at a 254nm wavelength into a sample cell. Mercury atoms absorb light with a 254nm wavelength. When a mercury atom in the sample cell absorbs the light, it is re-emitted at the same wavelength. A photo multiplier tube (PMT) is used to measure the light emitted at 90° to the source, which correlates to mercury concentration.



During instrument operation, ambient air is drawn through the intake by the pump at a nominal flow rate of one liter/minute. The sampled air then flows through either a scrubber filter and then into the sample cell or directly into the sample cell, as controlled by the valve, as shown below.

In the sample cell, the air sample is exposed to light with a 254nm wavelength. Any mercury present will absorb and then re-emit the light, and the re-emission is measured by the PMT. The PMT response during scrubbed flow is subtracted from the response during sample flow. The result correlates to mercury vapor concentration, which is calculated and displayed.


After analysis, the sample air is routed through the exhaust scrubber to absorb any mercury before the sample stream is discharged.



The instrument is designed and calibrated to elemental mercury vapor only.

6. INSTRUMENT OPERATION

6.1. Keypad

The keypad contains the power key  just to the right of the ▲ key. To turn on the instrument, hold down the power key until the display comes on. Turn off the instrument if it is not going to be used for an hour or more. Note, the instrument display remains on during charging.

Tests can be started with the TEST key on the keypad or the TEST button on the handle.

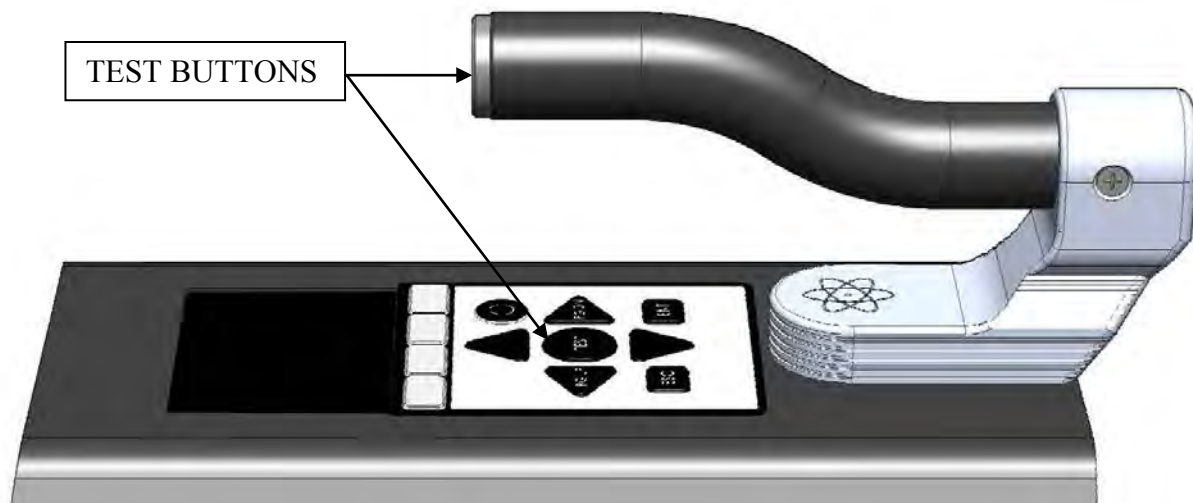
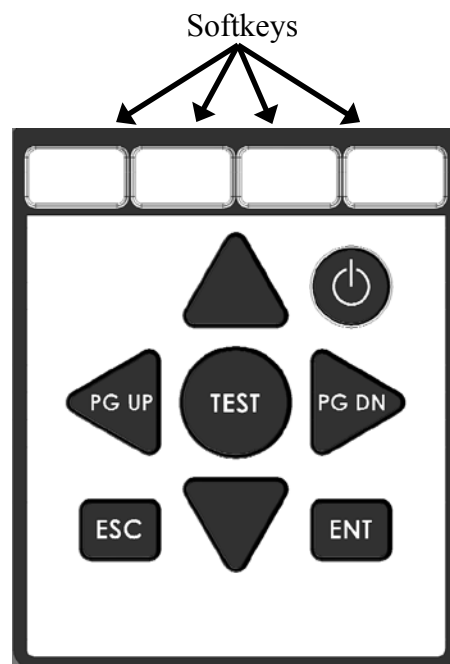
At the top of the keypad, just below the screen are four softkeys. The softkey functions change based on which screen is active.

Use the ▲, ▼, ◀, and ▶ keys to navigate menus and screens.


Use the ENTER key to select a menu item or field. While editing a field, ENTER saves the value.

Use the ESCape key to exit back to the prior menu. While editing a field, ESCape aborts the editing without saving any changes.


The ◀ and ▶ keys are also PG UP (Page Up) and PG DN (Page Down), which can be helpful for navigating through a long list of test results.



6.2. Power On and Warmup

Press the power key  to power on the instrument. The software revision is displayed on the startup screen.

A calibration reminder may be displayed right after the startup screen; if so, call AZI Customer Service at 800-528-7411 or 602-470-1414 or e-mail support@azic.com to schedule instrument calibration.

The screen displays  Warmup for about 6 minutes while the instrument is warming up and stabilizing. When the progress bar fills, Ready is displayed, and the instrument is ready for testing.



6.3. J505 Back Panel Connections

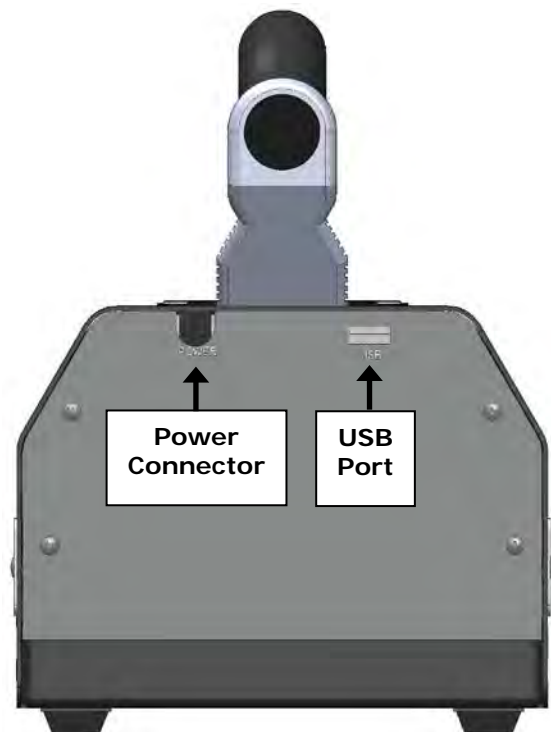
The power connector and the USB port are located at the rear of the instrument, as shown below.

POWER CONNECTOR - Connect the AC Adapter Power Supply to the power connector on the instrument, and use the line cord to provide AC power to the instrument and recharge the battery.

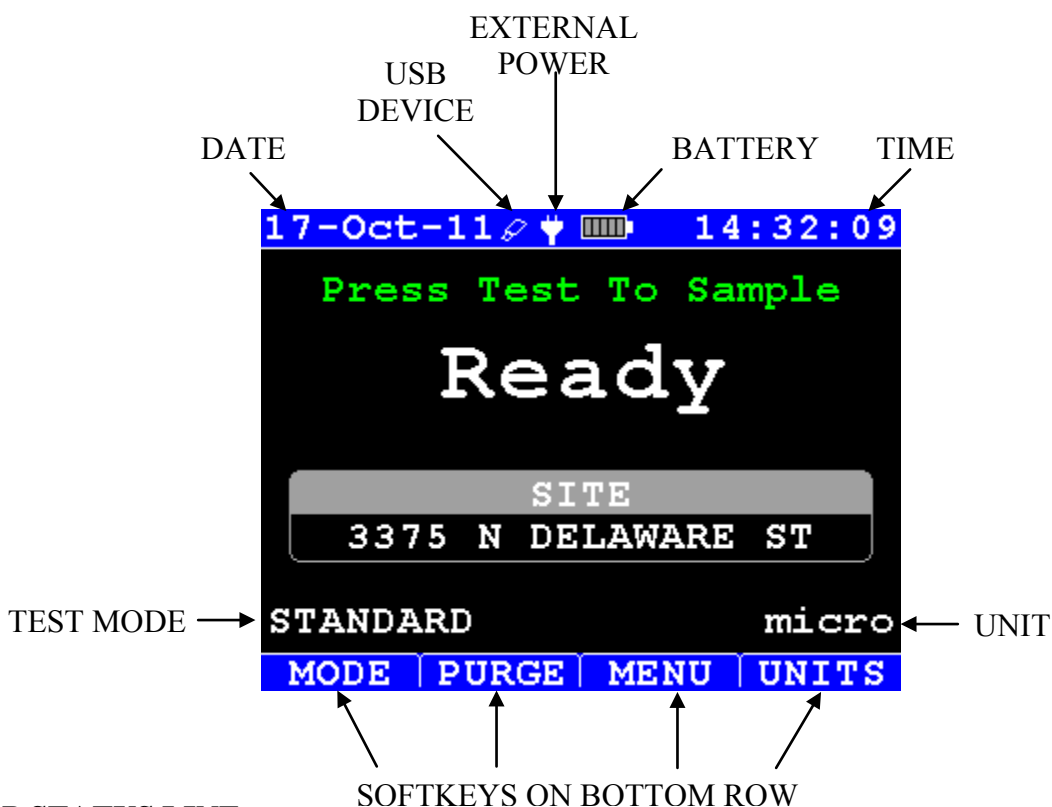
USB PORT – A USB keyboard or a USB flash drive can be installed in the USB port.

A USB keyboard can be used for menu navigation, text entry and soft key operation. Refer to **§6.4 Main Screen** for more information on the J505 menu structure and soft keys.

Test results and any calculations performed on the test results by the instrument can be exported to a USB flash drive. Refer to **§6.10 USB Test Result Output** for more information.



6.4. Main Screen



TOP STATUS LINE:

- **Date:** Displayed in day-month-2 digit year (dd-mmm-yy) format.
- **USB Device:** A flash drive or keyboard icon will be displayed when a corresponding device is detected by the instrument. USB hubs are not supported.
- **External Power:** A plug icon will show when external power is connected.
- **Battery:** The battery charge status is displayed by the number of the bars (5 maximum). During charging, the battery outline is red. Charging is initiated if external power is connected and the battery charge is < 95%. Charging takes 3 hours or less.
- **Time:** Displayed in a 24-hour format.

MODE:

The instrument has three test modes. The currently selected mode is indicated:

- **STANDARD** for normal sampling or detection of EPA or ATSDR cleanup levels,
- **QUICK** for faster sampling, and
- **SEARCH** for scanning an area to locate the source of contamination.

UNIT:

The instrument displays in three different measuring units. The currently selected unit is indicated:

- **nano:** the instrument will display in nanograms per cubic meter (ng/m^3)
- **micro:** the instrument will display in micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)
- **milli:** the instrument will display in milligrams per cubic meter (mg/m^3)

PROGRESS BAR: (shown on Warmup screen)

The progress bar is displayed for instrument warmup progress, purging progress and test progress.

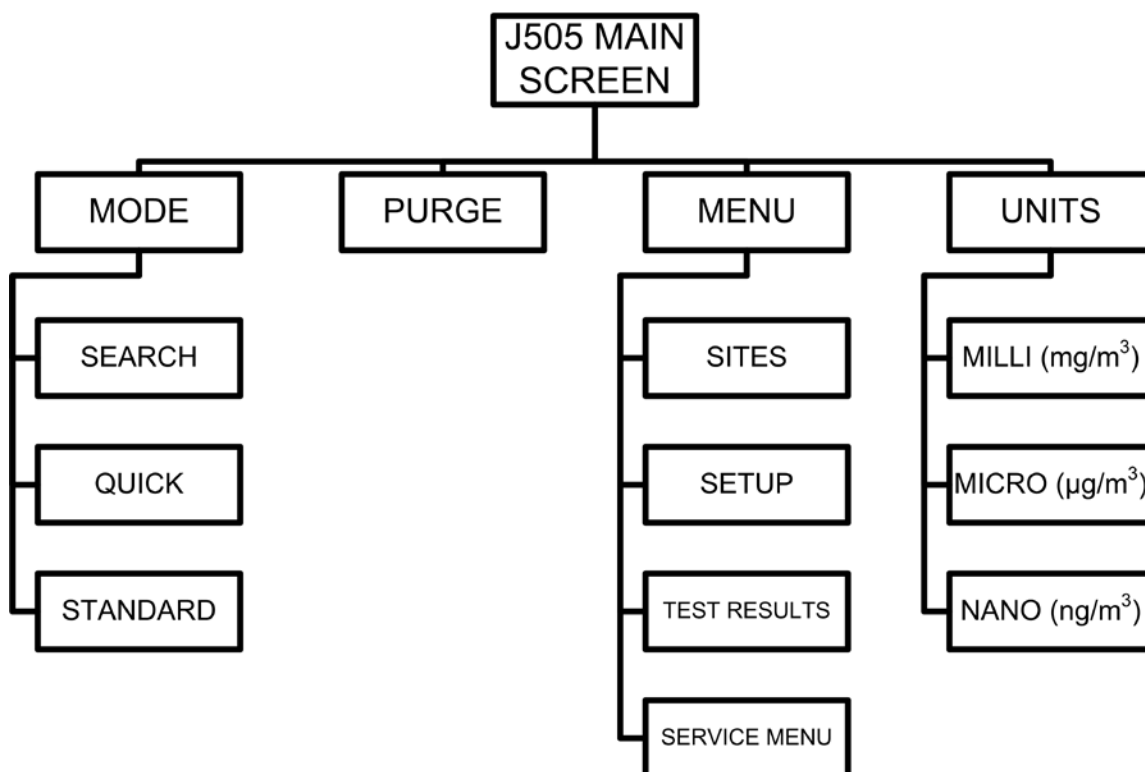
SITE:

The active test site is displayed. The active site is stored with the test result. The active site is changed through MAIN MENU→SITES.

SOFTKEYS:

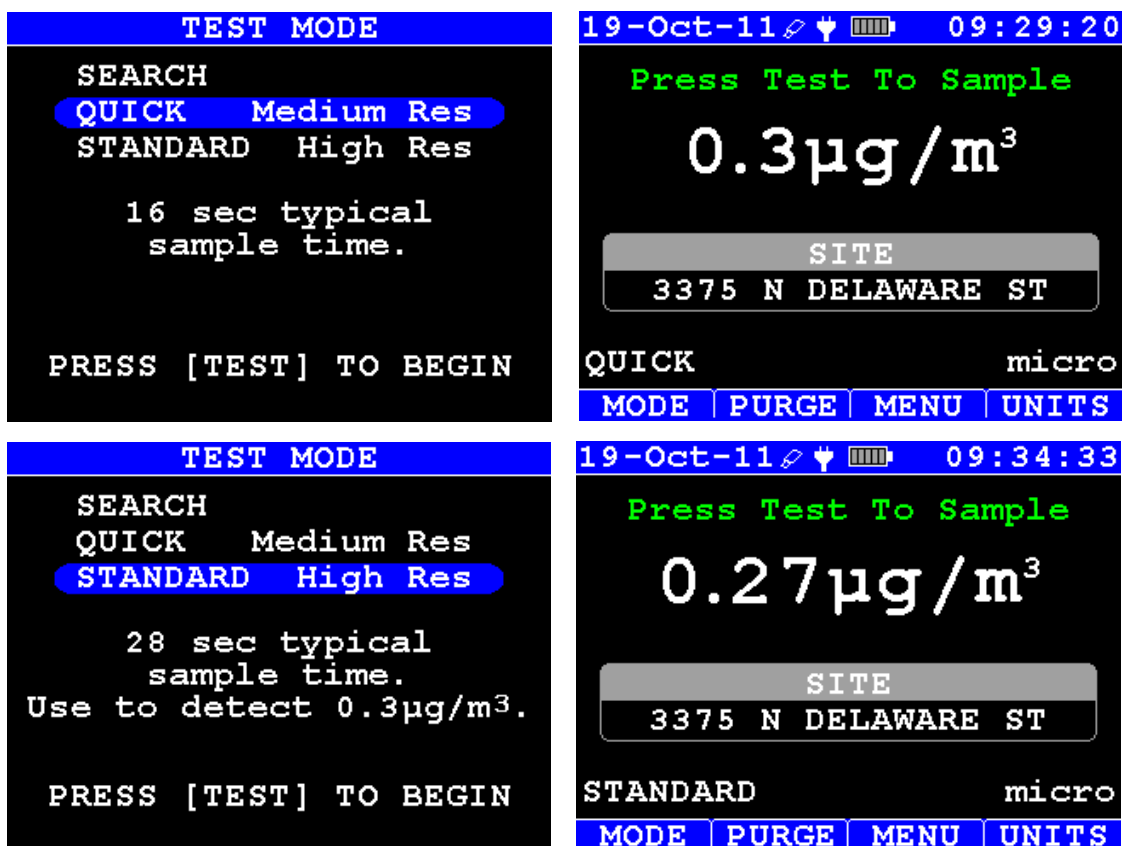
The softkeys on the Main Screen and their functions are described below. If a USB keyboard is connected, the F1-F4 keys on the keyboard can be used to operate the softkeys.

- **MODE** – Changes the test mode of the instrument. The currently selected test mode is displayed above the MODE softkey.
- **PURGE** – Turns the pump on (if off). “Purging” and a progress bar are displayed on the instrument and the pump runs for two (2) minutes. Using the Purge function is recommended for flushing the sample cell when switching from high to low levels of mercury. Sampling can be initiated at any time during the purging or while the pump is running. After two minutes of purging, the display will change to “Ready,” and the instrument will beep, while the pump continues to run for an additional two minutes. The pump also remains running for two minutes after a test. If the pump is off prior to a test, the test time for the next test will be increased to allow the instrument to capture an initial zero reading.
- **MENU** – Displays the MAIN MENU.
- **UNITS** – Changes the measuring unit. Test results are stored in the currently selected unit, which is indicated above the UNITS softkey.



6.5. Test Modes

The J505 has three test modes: Search, Quick and Standard. The desired test mode is selected using the MODE softkey on the Main Screen. As shown below, Standard provides the greatest resolution by utilizing a slightly longer sample time. Refer to **§4 TECHNICAL SPECIFICATIONS** on page 7 for complete details on the differences in sample time and resolution between the test modes.



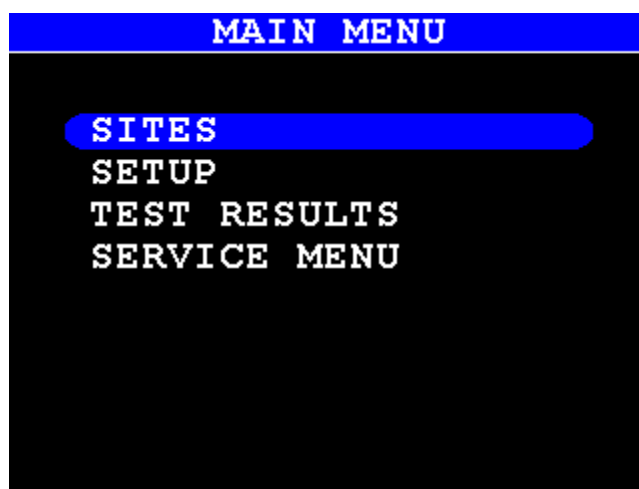
The difference in resolution between Quick and Standard test mode is also reflected in the number of decimal places shown on the Test Results screen, as shown below.

TEST RESULTS		
19-Oct	09:44	25.3
19-Oct	09:43	25.0
19-Oct	09:42	25.2
19-Oct	09:42	25.09
19-Oct	09:41	25.21
19-Oct	09:40	25.03
19-Oct	09:39	24.92
UNIT	SITE	15/43
µg/m³-3375 N DELAWARE ST		
DEL	SEL A	CALC USB

Search mode provides a stream of continuous relative readings that are displayed on the instrument but not saved in data storage.

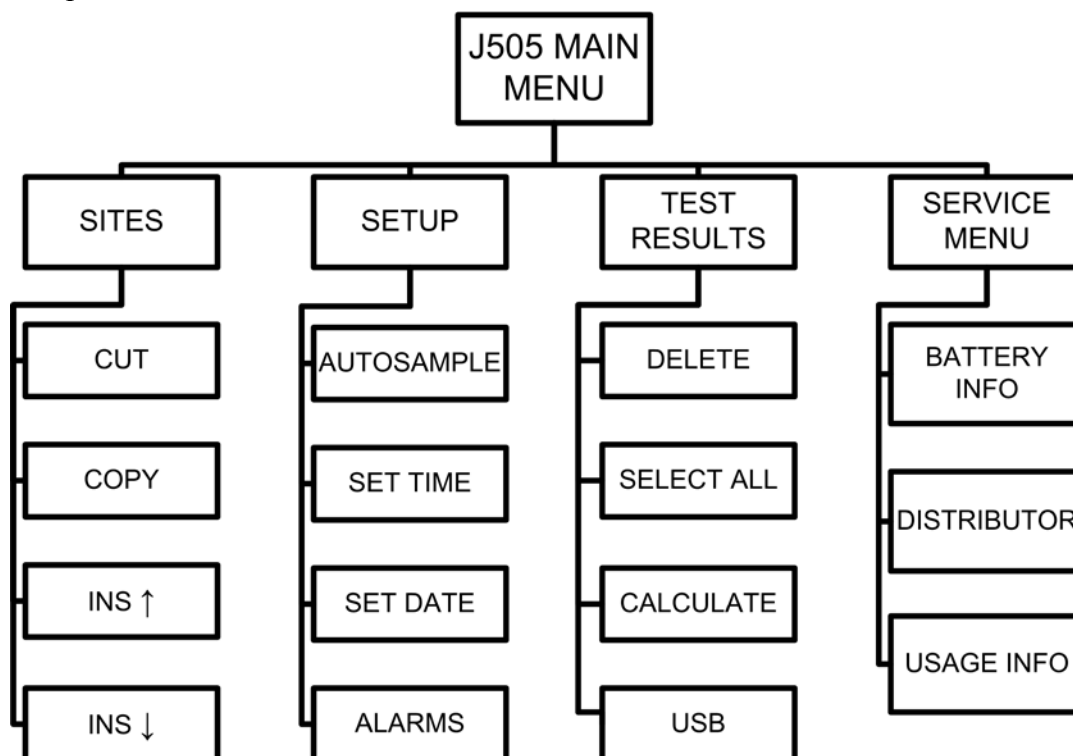
After Standard or Quick mode testing has determined that an area is contaminated, Search mode can be used to quickly locate the source of contamination. In Search mode, an initial zero reference reading is obtained, and then continuous readings are updated each second. Over a period of minutes, the mercury readings will drift slowly lower until clean air is sampled or testing is halted and restarted. The drift occurs only in Search Mode. Standard and Quick modes provide accurate individual readings.

6.6. Main Menu



Use ▲ and ▼ keys to move the selection bar and then press ENTER to select the desired menu.

Press ESCape to exit the Main Menu and return to the Main screen.

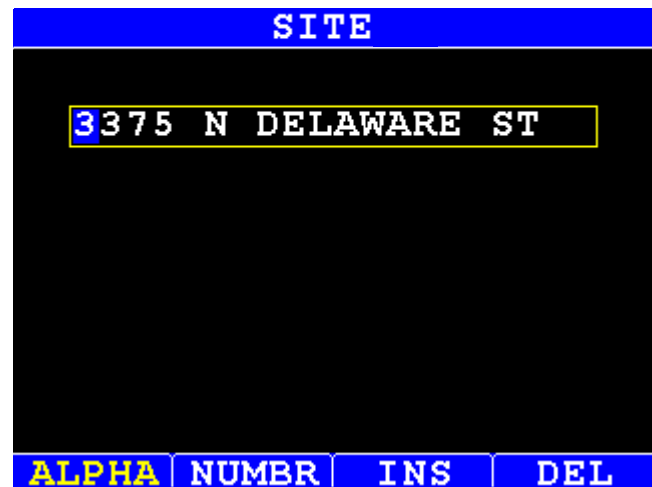
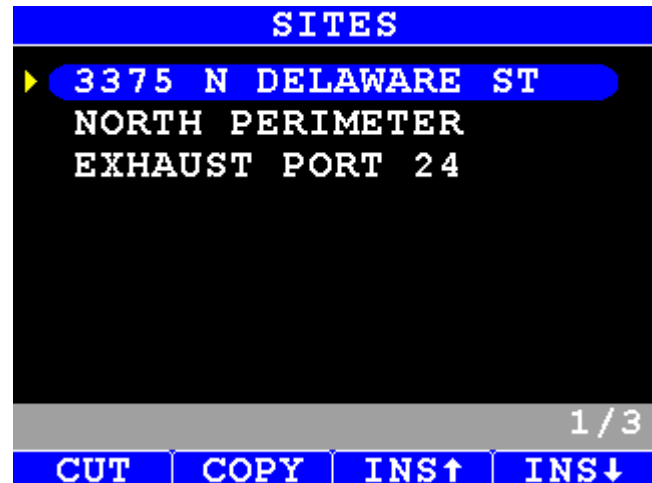


6.7. Sites List

Sites are created and edited through this screen and can be up to twenty (20) characters long. The J505 can store up to 100 sites.

The triangle indicates the active test site. The active site is saved with each corresponding test result. If desired, a technician name, test group or other identifier can be used instead of a site name. The site list is manipulated as follows:

- Use COPY and INS↑ (Insert above) or INS↓ (Insert below) to add a site.
- Use CUT to delete a site.
- Use CUT and INS↑ or INS↓ to move a site.
- Press ENTER, then ESCAPE to make the selected test site active.
- Press ENTER twice to edit the selected site.
 - Use ◀ and ▶ to select which digit to change.
 - For the selected digit, select ALPHA to select alphabetic digits or select NUMBR to select numerical digits, then use ▲ or ▼ to scroll through the alphabet or numbers.
 - Use INSert to insert a space.
 - Use DELeTe to delete a digit.
 - Use ENTER/ESCAPE to save or abort the edit.
- Connect a USB keyboard to the USB port to make editing test site names quick and easy. The USB port is located on the back of the instrument.



6.8. Setup Screen

Instrument configuration is changed through this screen. Use the arrow keys (\blacktriangle , \blacktriangledown , and \blacktriangleleft , \blacktriangleright) to move to the field to be edited. The currently selected field is indicated by the yellow highlight box. Then press ENTER to edit the field. Use the arrow keys to edit the value as desired, then press ENTER again to accept the changes or ESCape to exit without saving.

The editable fields are as follows:

- **AUTOSAMPLE:** The J505 can be set to take samples automatically at an interval of 1, 2, 5, 10, 15, 20, 30, 45, 60, 90 or 120 minutes. The Main Screen must be displayed for autosampling to take place and autosampling will start when the clock reads :00 seconds. If the instrument is autosampling, it will not shut off after 90 minutes on battery power.
- **TIME/DATE:** Use to set the time and date. Enter the time using a 24-hour format then press ENTER. After inputting the time and date, ESCape to the Main Screen to set these values.
- **RESULT ALARM:** The user may choose one of two separate high limit alarms A or B, or disable it (Off). Either alarm may be set to any value, but typically one is set to the residential cleanup level and one to the industrial cleanup level. If the selected high limit is exceeded, an audible alarm occurs, the word “ALARM” is added to the record saved to a USB flash drive, and the result is displayed in red on the Main Screen and the Test Results screen, as shown below. The alarm level values are always specified in $\mu\text{g}/\text{m}^3$ when input and displayed on this screen. However, the alarm capabilities are still functional when the J505 is set to display in ng/m^3 or mg/m^3 ; the specified alarm values are appropriately adjusted internally so that alarm level readings trigger the alarm regardless of the display units in use.

For reference: $1 \text{ mg}/\text{m}^3 = 1,000 \text{ } \mu\text{g}/\text{m}^3 = 1,000,000 \text{ ng}/\text{m}^3$.

SETUP

AUTOSAMPLE: Off

TIME: 14 : 45

DATE: 17 - Oct - 2011

RESULT ALARM: Off

A ($\mu\text{g}/\text{m}^3$) : 1.00

B ($\mu\text{g}/\text{m}^3$) : 25.00

19-Oct-11 09:14:50

Press Test To Sample

1.38 $\mu\text{g}/\text{m}^3$

SITE

3375 N DELAWARE ST

STANDARD **micro**

MODE **PURGE** **MENU** **UNITS**

TEST RESULTS

19-Oct	09:25	0.28
19-Oct	09:24	0.29
19-Oct	09:23	0.30
19-Oct	09:22	1.29
19-Oct	09:21	1.33
19-Oct	09:20	1.37
19-Oct	09:18	1.38

UNIT **SITE** 31/42

$\mu\text{g}/\text{m}^3$ - 3375 N DELAWARE ST

DEL **SEL A** **CALC** **USB**

6.9. Test Results List

Test results are viewed, analyzed or saved to a flash drive on this screen.

The UNIT and SITE of the selected test result are displayed at the bottom of the screen, along with the test number and the total number of tests. ALARM readings are displayed in red.

TEST RESULTS		
▶ 19-Oct 10:39	25.06	
▶ 19-Oct 10:38	25.04	
▶ 19-Oct 10:37	25.02	
▶ 19-Oct 10:36	24.93	
▶ 19-Oct 10:35	25.00	
19-Oct 10:34	0.01	
19-Oct 09:36	0.27	
UNIT	SITE	8/34
$\mu\text{g}/\text{m}^3$ -3375 N DELAWARE ST		
DEL	SEL A	CALC USB

TEST RESULTS		
19-Oct 09:24	0.29	
19-Oct 09:23	0.30	
▶ 19-Oct 09:22	1.29	
▶ 19-Oct 09:21	1.33	
▶ 19-Oct 09:20	1.37	
▶ 19-Oct 09:18	1.38	
▶ 19-Oct 09:17	1.36	
UNIT	SITE	38/42
$\mu\text{g}/\text{m}^3$ -3375 N DELAWARE ST		
DEL	SEL A	CALC USB

The following options are available:

- A range of test results are selected by pressing ENTER on each desired result. To unselect, press ENTER again.
- DELEte deletes a single or selected range of test results from memory. The data memory allows storage of up to 10,000 results. If the memory becomes full, the user is warned and new test results are displayed but not saved. After deleting tests, the instrument power must be cycled to make the cleared memory available for storage again.
- SEL_A selects all or unselects all test results.
- CALC calculates the average and standard deviation (SD) of the selected results and displays them as shown below. If necessary, when a group of readings is selected for analysis, they are converted to a common set of units for display.
- USB saves a single or selected range of results to a connected USB flash drive in a text file named 505#####.TXT, where 505##### is the instrument serial number. Install the USB flash drive in the USB port on the rear of the instrument, select the desired test results and press the USB soft key to save the selected data to the flash drive. If the text file already exists on the USB flash drive, the instrument will prompt to APPEND, OVERWRITE or CANCEL.

On the Test Result Analysis screen:

- USB saves the selected test results and the displayed test result analysis to a flash drive.
- If the text file already exists on the USB flash drive, the instrument will prompt to APPEND, OVERWRITE or CANCEL.

TEST RESULT ANALYSIS	
COUNT:	5
AVERAGE:	25.01 $\mu\text{g}/\text{m}^3$
SD:	0.05 $\mu\text{g}/\text{m}^3$
USB	

6.10. USB Test Result Output

Test results and analyses written to a flash drive are saved in a file named 505#####.TXT, where 505##### is the instrument serial number. The file is readily opened with spreadsheet software for further analysis if desired. If the file already exists on the flash drive, the instrument will prompt to APPEND, OVERWRITE or CANCEL.

The data file is formatted as shown in the example below. Each set of data will begin with the standard four line header shown, indicating test results or test result analysis, the date and time the file was written, and the instrument serial number. Following the header, the column labels are displayed, followed by the selected data. ALARM readings will have "ALARM" in the ALARM column. If the results were analyzed, the count, mean and standard deviation will be listed following the data that was analyzed, as shown below.

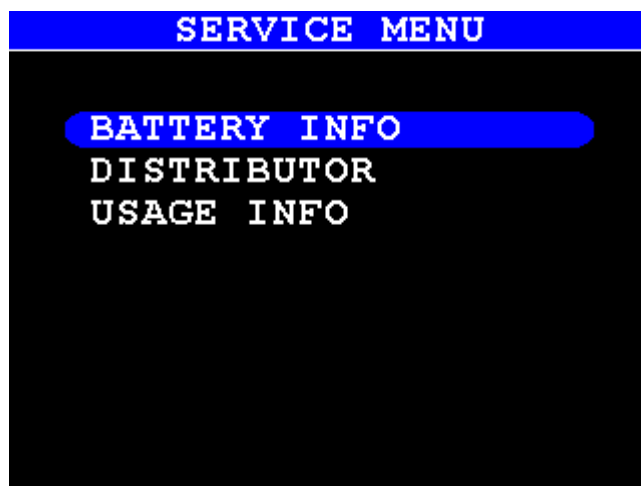
If data is appended to an existing file, a dashed line will separate each set of data in the file.

```
-----
J505 TEST RESULTS
DATE: 19-Oct-11
TIME: 10:43:55
SERIAL NUMBER: 50500003
-----
DATE, TIME, RESULT, UNIT, ALARM, SITE
-----
19-Oct-11,10:35:29, 25.00,µg/m3,,3375 N DELAWARE ST
19-Oct-11,10:36:29, 24.93,µg/m3,,3375 N DELAWARE ST
19-Oct-11,10:37:29, 25.02,µg/m3,,3375 N DELAWARE ST
19-Oct-11,10:38:29, 25.04,µg/m3,,3375 N DELAWARE ST
19-Oct-11,10:39:29, 25.06,µg/m3,,3375 N DELAWARE ST
-----
J505 TEST RESULT ANALYSIS
DATE: 19-Oct-11
TIME: 10:23:07
SERIAL NUMBER: 50500003
-----
DATE, TIME, RESULT, UNIT, ALARM, SITE
-----
19-Oct-11,09:17:29, 1.36,µg/m3,ALARM,3375 N DELAWARE ST
19-Oct-11,09:18:29, 1.38,µg/m3,ALARM,3375 N DELAWARE ST
19-Oct-11,09:20:29, 1.37,µg/m3,ALARM,3375 N DELAWARE ST
19-Oct-11,09:21:29, 1.33,µg/m3,ALARM,3375 N DELAWARE ST
19-Oct-11,09:22:29, 1.29,µg/m3,ALARM,3375 N DELAWARE ST

COUNT: 5
MEAN: 1.35µg/m³
SD: 0.04µg/m³
```

6.11. Service Menu

The Service Menu is used to view detailed battery information, access distributor contact information or view instrument usage statistics, as explained in the following sections.

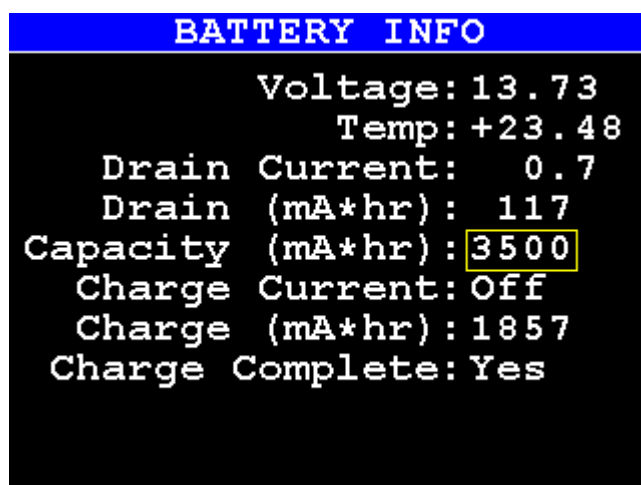


6.12. Battery Info Screen & Battery Management

The Battery Info screen displays detailed battery status.

The most important information is the “Capacity (mA*hr)”. A battery with greater than 2,700 mA*hr typically provides 10 or more hours of instrument operation when autosampling at five-minute intervals. As the battery ages, the capacity slowly drops.

If the J505 is running on battery power, it will automatically shut off 90 minutes after last use, unless the instrument is autosampling.



The “Drain (mA*hr)” and “Capacity (mA*hr)” are used to determine the battery charge level, which is displayed on the Main Screen as bars (5 maximum) in the battery icon.

The battery capacity is calculated when the battery is fully discharged.

To update the battery capacity once a year:

- Turn on the instrument,
- Fully charge the instrument,
- Disconnect external power,
- Allow the instrument to fully discharge

When fully discharged, the instrument will automatically save the battery capacity and turn off. Afterwards, charge the instrument and use as normal.

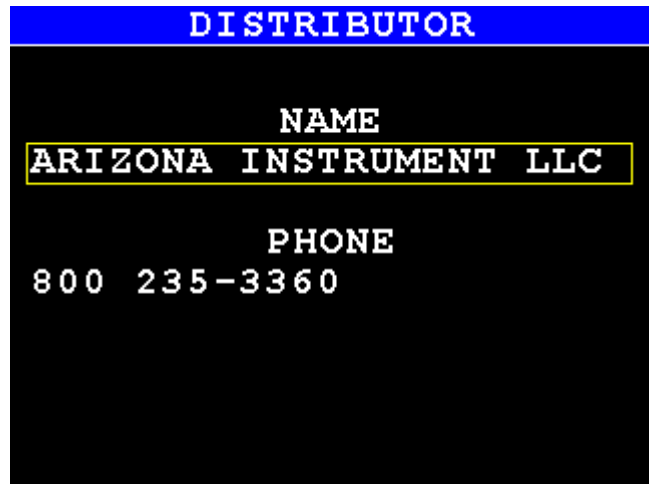
Note: the battery will not charge if the battery temperature is greater than 40 °C.

The battery pack uses NiMH chemistry, which will self-discharge over several months. If the instrument is not used for a month or longer, plug the instrument in every month to recharge or leave it plugged in when not in use. Leaving the instrument unplugged for several months will damage the battery capacity.

6.13. Distributor Information Screen

The Distributor screen displays a name and contact phone number for Arizona Instrument or one of our authorized distributors or instrument rental companies.

The information on this screen is edited in the same fashion as other text fields, using either the instrument keypad or a USB keyboard.

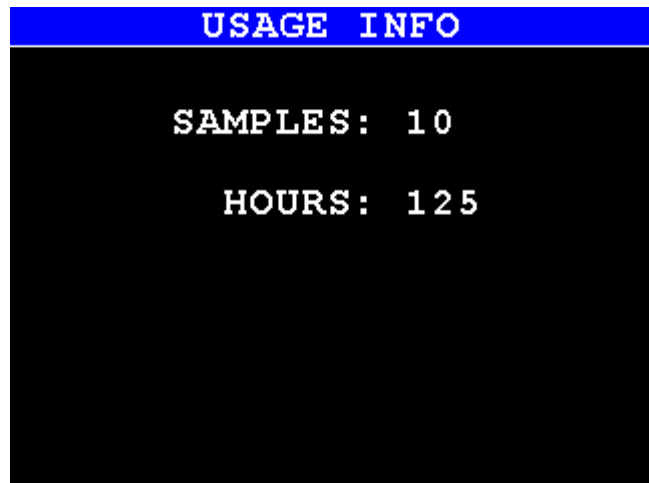


A screenshot of the 'DISTRIBUTOR' screen. The title 'DISTRIBUTOR' is at the top in a blue bar. Below it, the word 'NAME' is centered. Under 'NAME', the text 'ARIZONA INSTRUMENT LLC' is displayed within a yellow rectangular border. Below this, the word 'PHONE' is centered. Under 'PHONE', the text '800 235-3360' is displayed.

DISTRIBUTOR
NAME
ARIZONA INSTRUMENT LLC
PHONE
800 235-3360

6.14. Usage Info Screen

The Usage Info screen displays instrument samples and hours powered up since the last factory service, as shown.



A screenshot of the 'USAGE INFO' screen. The title 'USAGE INFO' is at the top in a blue bar. Below it, the text 'SAMPLES: 10' is displayed. Below that, the text 'HOURS: 125' is displayed.

USAGE INFO
SAMPLES: 10
HOURS: 125

7. MAINTENANCE

7.1. Zero Air Filter

The Zero Air Filter (AZI P/N Z2600 3905) can be used to verify proper instrument operation. The Zero Air Filter removes mercury vapor from the air sample. Readings with the filter installed should be less than $0.05 \mu\text{g}/\text{m}^3$. If readings with the filter installed are not below $0.05 \mu\text{g}/\text{m}^3$, change the intake fritware filter. See **7.3 Flow System** on page **22** for instructions.

7.2. Preventive Maintenance Schedule

To keep the instrument operating at peak performance, follow the maintenance schedule below as a guide. Because maintenance is more a function of application and amount of use rather than time, your requirements may be different from the listed schedule. Call AZI Customer Service at 800-528-7411 or 602-470-1414, or e-mail support@azic.com for additional guidance for your environment and operation.

PART/COMPONENT	MAINTENANCE CYCLE	REFER TO PAGE
Battery	See section 6.11 Battery Info Screen & Battery Management for guidelines.	Page 19
Change intake fritware	Weekly or as needed	Page 22
Factory calibration and filter replacement	Annually	

There are no user serviceable components or assemblies inside the J505 and the instrument should not be opened except by factory-authorized technicians at Arizona Instrument. Unauthorized opening of the instrument will void the instrument warranty.

7.3. Flow System

The flow system is the crucial link between the sample cell and the test environment. For the instrument to perform correctly, the flow system must be properly maintained. The only user maintainable component of this system is the intake fritware filter.

Replace the fritware filter once each week or as needed. In dusty environments, the fritware filter may need to be replaced on a daily basis. Replacement fritware filters are available from AZI Consumable Sales at 800-528-7411 or 602-470-1414 as AZI part number 345-0241.

- NOTE: It is not necessary to open the instrument to change the fritware filter.
- Turn the instrument off.
- Unscrew the knurled intake by hand and remove it. (The fritware is housed in the knurled intake). (*Fig. 1*)
- Insert the tweezers included with the instrument into the small end of the knurled intake and gently apply pressure to push the old fritware filter out through the larger end of the intake. (*Fig. 2*). If necessary, use the tweezers to finish pulling the fritware filter out through the larger end of the intake.
- Insert a new fritware filter through the large end of the intake so that the smoother, flatter side of the fritware will be facing out of the instrument. Keep the fritware flat and gently press it into the threaded hole using the backend of the tweezers. (*Fig. 3*). Re-installing the intake in the next step will properly position the fritware behind the o-ring, so it is not necessary to press the fritware all the way in by hand.
- Screw the knurled intake back on to the J505. (*Fig.4*) This will seat the fritware behind the o-ring in the intake.



Figure 1



Figure 2



Figure 3

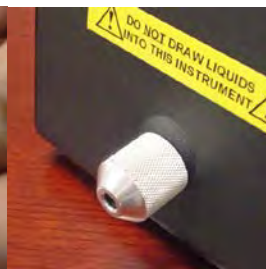


Figure 4

The other internal filters should only be replaced by the factory. Opening the instrument case or attempting to change or remove the internal filters will void the instrument warranty.



CAUTION

Internal filters contain Resisorb[®]. Used filters will contain trace amounts of Mercury also. Call AZI Customer Service at 800-528-7411, 602-470-1414, or e-mail support@azic.com for a copy of the Resisorb[®] MSDS or for other questions.

8. CALIBRATION

8.1. Factory Calibration Service

The interval between calibrations depends upon the application and frequency of use; however, the recommended interval is every 12 months.

The instrument has been factory calibrated using laboratory equipment containing NIST traceable permeation tubes. In order to calibrate the instrument, a sophisticated calibration system is required that ensures stability of the calibration gas source, eliminates any pressure in the calibration gas stream, and controls the temperature of the calibration environment.

We strongly recommend you take advantage of our calibration and maintenance service at Arizona Instrument. Service includes filter replacement, component testing, and instrument calibration to NIST traceable standards. A certificate of calibration is issued from AZI when your instrument is factory calibrated.

For scheduling and shipping authorization, call AZI Customer Service at (800) 528-7411 or (602) 470-1414 or visit our website at www.azic.com.


9. INTERFERENCES

In general, interferences to the Jerome[®] J505 Mercury Vapor Analyzer are minimal. Testing has shown a negligible instrument response to chlorine, ammonia, humidity/water vapor and gasoline vapors.

While instrument response to humidity is negligible, moving the instrument from an air conditioned environment to one of higher temperature and humidity may cause condensation on some of the optical surfaces. For best results, it is recommended to allow the instrument to equilibrate to ambient conditions before testing. The PURGE softkey can also be used to flush the instrument and accelerate environmental acclimation.

The J505 has a slight response to acetone vapor. In an environment with a high concentration of gaseous acetone (≈ 1100 ppmv acetone), instrument response is approximately 100 nanograms/m³.

10. TROUBLESHOOTING

Symptom	Possible Cause	Solution
Power Problems		
Instrument does not turn ON or turns off automatically	Discharged battery	Recharge the battery for 3 hours.
Display Warnings and Error Messages		
 Error	Light source or component failure	Call AZI Customer Service at 800-528-7411 or 602-470-1414.
	If testing in very cold conditions, this error may occur due to insufficient lamp warmup time.	Cycle power to the instrument off and then back on and allow it to continue warming up.
TEST RESULT MEMORY LOW	Over 9,000 test results are stored in the instrument.	Informational message only.
TEST RESULT MEMORY FULL READING NOT SAVED or TEST RESULT MEMORY FULL AUTOSAMPLE DISABLED	10,000 test results are stored in the instrument and there is not room for additional test results	Save data to USB flash drive if desired, then delete data. See 6.8 Test Results List on page 17.
USB FILE FAILURE	Unformatted or corrupt flash drive	Format flash drive or try different flash drive
Instrument Performance		
Readings with the Zero Air Filter installed are not less than $0.05\mu\text{g}/\text{m}^3$.	Contaminated intake fritware filter.	Change intake fritware filter. See 7.3 Flow System on page 22 for instructions.
	Contaminated flow system	Set the instrument to Autosample at 1-minute intervals for 1 hour to purge the flow system. See §6.7 on page 16.

11. ACCESSORIES & MAINTENANCE PARTS

PART #	ITEM DESCRIPTION
Y505-0901	J505 Accessory Kit
200-0235	Line Cord, 115 VAC - USA and Canada (3ft)
alternate 200-0003	Line Cord, 220-240 VAC – England
alternate 200-0008	Line Cord, 220-240 VAC – Europe
345-0241	Fritware for J505 (1 pack of 5 fritware filters)
690-0012	Tweezers
990-0219	USB Flash Drive
990-0244	AC Adapter Power Supply (power supply/charger)
1400 2002	Probe
1400 3010	Tubing Adapter, 1/4" to 1/8"
Z2600 3905	Zero Air Filter

11.1. Spare Parts and Accessories

200-0235
(200-0003)
(200-0008)

100-120 VAC Line Cord
(220 VAC Line Cord – UK)
(220 VAC Line Cord – Europe)



345-0241

Fritware for J505 (1)



690-0012

Tweezers



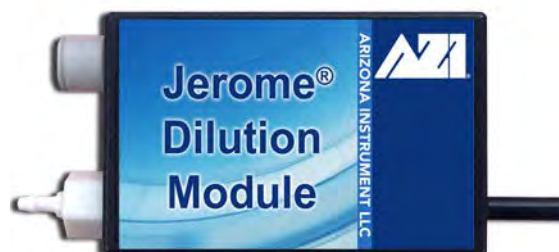
990-0219

USB Flash Drive



990-0223

10-to-1 Dilution Module



990-0230 USB Keyboard



**990-0244 AC Adapter Power Supply
(supply/charger)**



990-0246 Soft Handle Grip
Use a few drops of dish
soap to install, then let dry
completely before use



990-0247 Soft Carrying Case
Includes a shoulder strap
and pockets to hold supplies
or accessories



1400 2002 Probe



1400 3010 Tubing adapter



Y990-0234 Mercury Spill Kit



Z2600 3905 Zero Air Filter



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12. WARRANTY

Arizona Instrument LLC (seller) warrants to buyer that Jerome® products delivered pursuant to this agreement shall, at the time of delivery, and for a period of one (1) year thereafter (the Internal Battery Pack, where applicable, is warranted for a period of ninety [90] days only), be free from defects in material or workmanship and shall conform to seller's specifications or such other specifications as seller has agreed to in writing. Seller's obligations with respect to claims under this warranty shall be limited, at seller's option, either to the replacement of defective or non-conforming product or to an appropriate credit for the purchase price thereof subject to the provisions of seller's Warranty Policy as amended from time to time, said Policy being incorporated herein by reference. All defective parts replaced by AZI become the property of AZI.

Returned products under warranty claims will be shipped to seller's plant by buyer at buyer's expense and shall be accompanied by a statement of the reason for the return and an approved Return Material Authorization Number issued by seller. Buyer remains responsible for payment for products not accepted for warranty adjustment, handling costs, and freight costs associated therewith.

Notwithstanding the foregoing, no warranty shall be enforceable in the event that product has been subjected to environmental or stress testing by buyer or any third party without written approval of seller prior to such testing. Further, no warranty shall be enforceable if the alleged defect is found to have occurred because of misuse, neglect, improper installation, repair, alteration, accident, or improper return handling procedure by buyer. Additionally, no warranty shall be enforceable if the instrument has been opened or the instrument's internal components subjected to inspection without prior written approval of seller. **Any unauthorized opening or internal inspection of the instrument shall make this warranty null and void.**

Discontinued product is warranted only for a credit or replacement at seller's option.

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Arizona Instrument LLC

Jerome[®] J505 Mercury Vapor Analyzer Operation Manual Part Number 700-0130

If you have any questions regarding the operation of this instrument, please call our toll free number (800) 528-7411. Internationally, call (602) 470-1414 or fax (480) 804-0656.

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Sample Setup Guide

Sampling Train — Single Sorbent Sample Tube



Sorbent tube sampling is the NIOSH/OSHA-approved method for collecting most hazardous gases and vapors from the air. The sorbent tube is glass with breakable end tips and contains a specially prepared high-activity sorbent. Most tubes have two sections: one for sample collection and the other for backup. This configuration provides a check against saturation of the primary sorbent bed. This Sample Setup Guide demonstrates how to set up a **Sampling Train Using Sorbent Sample Tubes**.

Required Equipment

1. An **air sample pump** capable of sampling at the recommended flow rate with the sampling medium in line, such as:
 - SKC Pocket Pump® TOUCH with Low Flow Tube Holder Cat. No. 222-3 Series
 - SKC AirChek® Series with All-in-One Low Flow Adapter/Holder Cat. No. 224-27
2. An **airflow calibrator** such as:
 - SKC chek-mate Calibrator Cat. No. 375-07550N
 - TSI 4146 Calibrator Cat. No. 740-4146
3. The **sorbent sample tube** specified in the method
4. The **appropriate protective tube cover**

Optional Equipment

1. SKC **Tube Breaker** Cat. No. 222-3-50 (for 6 and 7-mm OD tubes) or 222-3-51 (for 8 and 10-mm OD tubes)

Introduction

This guide shows sampling and calibration trains with the SKC Pocket Pump TOUCH sample pump. For the low flow Pocket Pump TOUCH, use the single low flow tube holder. For SKC AirChek Series sample pumps, use the All-in-One low flow adapter/holder for sampling at flow rates below 1000 ml/min (not necessary for flow rates greater than 1000 ml/min).

To determine the correct flow rate for the chemical of interest, refer to the appropriate analytical method. *See the operating instructions for the applicable pump to ensure that it can sample at the correct flow rate.*

1. Preparing the Sorbent Tube

Using a tube breaker, break off both ends of a representative sorbent tube to provide an opening of at least one-half the internal diameter of the tube. This tube will be used for calibrating the flow and not for collecting the sample.

2. Setting up the Sampling and Calibration Trains — Figures 1 and 2

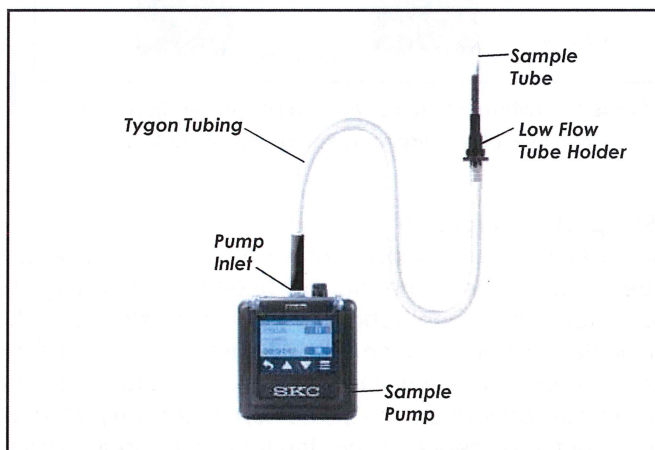


Figure 1. Sampling train with single (non-adjustable) low flow tube holder and Pocket Pump TOUCH

For a low flow pump: connect flexible tubing from the pump inlet to the tube holder. Place the sorbent tube into the black rubber sleeve of the tube holder. The printed arrow on the sorbent tube shows the direction of airflow and should point toward the pump. If there is no arrow printed on the tube, insert the end of the tube with the smallest sorbent section (backup section) into the tube holder.

If using an AirChek Series pump: connect the All-in-One flexible tubing to the pump inlet. Place the sorbent tube in the black rubber sleeve on the tube holder. The printed arrow on the sorbent tube shows the direction of airflow and should point toward the holder. If no arrow is printed on the tube, insert the end of the tube with the smallest sorbent section (backup section) into the holder.

Sampling Train — Single Sorbent Sample Tube

3. Calibrating the Flow Rate — Figure 2

Allow the pump to equilibrate from one temperature extreme to another and to run for 5 minutes before calibrating. To calibrate the flow rate, connect the open end of the sorbent tube to an external calibrator. Calibrate to the flow rate specified in the analytical method for the chemical of interest. If using the All-in-One, turn the flow adjust screw on the holder to adjust flow rate. *See the pump and calibrator operating instructions for calibrating the flow rate.* When the flow rate has been calibrated and verified, remove the sorbent tube used to calibrate the flow and set it aside. This tube will be used to verify the flow rate after sampling. Record the pre-sample flow rate. Remove the external calibrator.

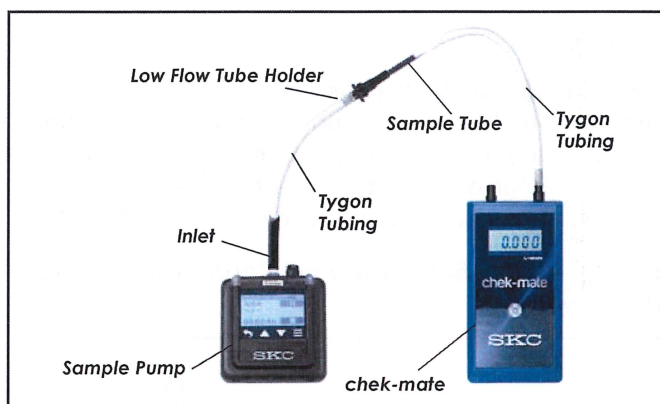


Figure 2. Calibration train using a single (non-adjustable) low flow tube holder and Pocket Pump TOUCH

4. Sampling — Figure 3

When ready to start sampling, break off both ends of a new sorbent tube in the same manner used for calibrating the flow. Insert the sorbent tube into the rubber sleeve of the tube holder (printed arrow on the tube should point toward the pump; if there is no arrow, insert the end of the tube with the smallest sorbent section into the holder). Place the protective cover over the sorbent tube, clip the tube to a worker's collar, and attach the pump to the worker's belt. The sorbent tube should be placed in a vertical position during sampling. Turn on the pump and note the start time and any other sampling

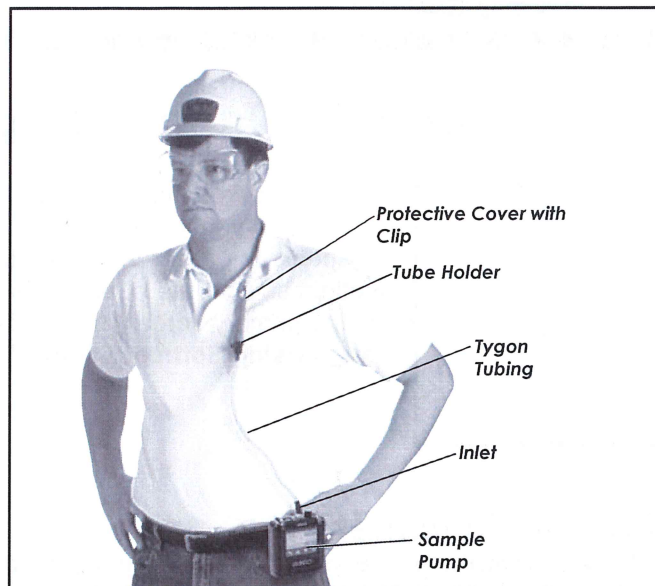


Figure 3. Worker wearing a sorbent tube sampling train

information.

5. After Sampling

At the end of the sampling period, turn off the pump and note the ending time. Remove the sorbent tube, seal the ends of the tube with the caps provided, and record pertinent sampling information.

Using a calibrator, calibrate the flow rate with a representative sorbent tube in line to verify that the flow has not changed by more than 5%.

Submit field blanks from the same lot number as the sample tubes. Field blanks should be subjected to exactly the same handling as the samples (break, seal, and transport) except that no air is drawn through them.

Pack the sample sorbent tubes, field blanks, and all pertinent information securely for shipment to a laboratory for analysis.

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- **Set up real-time networks:** Access data 24/7 and receive event notifications when you connect data loggers to Tube and Cube Telemetry Systems, HydroVu Data Services, or other third-party data collection platforms.

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- Long-term, real-time groundwater & surface water monitoring
- Mining & remediation

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General	Level TROLL 400	Level TROLL 500	Level TROLL 700	Level BaroTROLL
Temperature ranges¹	Operational: -20 to 80° C (-4 to 176° F) Storage: -40 to 80° C (-40 to 176° F) Calibrated: -5 to 50° C (23 to 122° F)	Operational: -20 to 80° C (-4 to 176° F) Storage: -40 to 80° C (-40 to 176° F) Calibrated: -5 to 50° C (23 to 122° F)	Operational: -20 to 80° C (-4 to 176° F) Storage: -40 to 80° C (-40 to 176° F) Calibrated: -5 to 50° C (23 to 122° F)	Operational: -20 to 80° C (-4 to 176° F) Storage: -40 to 80° C (-40 to 176° F) Calibrated: -5 to 50° C (23 to 122° F)
Diameter	1.83 cm (0.72 in.)	1.83 cm (0.72 in.)	1.83 cm (0.72 in.)	1.83 cm (0.72 in.)
Length	21.6 cm (8.5 in.)	21.6 cm (8.5 in.)	21.6 cm (8.5 in.)	21.6 cm (8.5 in.)
Weight	124 g (0.27 lb)	124 g (0.27 lb)	124 g (0.27 lb)	124 g (0.27 lb)
Materials	Titanium body; Delrin® nose cone	Titanium body; Delrin nose cone	Titanium body; Delrin nose cone	Titanium body; Delrin nose cone
Output options	Modbus/RS485, SDI-12, 4 to 20 mA	Modbus/RS485, SDI-12, 4 to 20 mA	Modbus/RS485, SDI-12, 4 to 20 mA	Modbus/RS485, SDI-12, 4 to 20 mA
Battery type & life²	3.6V lithium; 10 years or 2M readings	3.6V lithium; 10 years or 2M readings	3.6V lithium; 10 years or 2M readings	3.6V lithium; 10 years or 2M readings
External power	8 to 36 VDC	8 to 36 VDC	8 to 36 VDC	8 to 36 VDC
Memory	2.0 MB	2.0 MB	4.0 MB	1.0 MB
Data records³	120,000	120,000	250,000	60,000
Data logs	50 logs	50 logs	50 logs	2 logs
Fastest logging rate	2 per second	2 per second	4 per second	1 per minute
Fastest output rate	Modbus: 2 per second SDI-12 & 4 to 20 mA: 1 per second	Modbus: 2 per second SDI-12 & 4 to 20 mA: 1 per second	Modbus: 2 per second SDI-12 & 4 to 20 mA: 1 per second	Modbus: 2 per second SDI-12 & 4 to 20 mA: 1 per second
Log types	Linear, Fast Linear, and Event	Linear, Fast Linear, and Event	Linear, Fast Linear, Linear Average, Event, Step Linear, True Logarithmic	Linear
Sensor Type/Material	Piezoresistive; titanium	Piezoresistive; titanium	Piezoresistive; titanium	Piezoresistive; titanium
Range	Absolute (non-vented) 30 psia: 11 m (35 ft) 100 psia: 60 m (197 ft) 300 psia: 200 m (658 ft) 500 psia: 341 m (1120 ft)	Gauged (vented) 5 psig: 3.5 m (11.5 ft) 15 psig: 11 m (35 ft) 30 psig: 21 m (69 ft) 100 psig: 70 m (231 ft) 300 psig: 210 m (692 ft) 500 psig: 351 m (1153 ft)	Absolute (non-vented) 30 psia: 11 m (35 ft) 100 psia: 60 m (197 ft) 300 psia: 200 m (658 ft) 500 psia: 341 m (1120 ft) 1000 psia: 693 m (2273 ft) Gauged (vented) 5 psig: 3.5 m (11.5 ft) 15 psig: 11 m (35 ft) 30 psig: 21 m (69 ft) 100 psig: 70 m (231 ft) 300 psig: 210 m (692 ft) 500 psig: 351 m (1153 ft)	30 psia (usable up to 16.5 psi; 1.14 bar)
Burst Pressure	Max. 2x range; burst > 3x range	Max. 2x range; burst > 3x range	Max. 2x range; burst > 3x range	Vacuum/over-pressure above 16.5 psi damages sensor
Accuracy (FS)⁴	±0.05%	±0.05%	±0.05%	±0.05%
Long-Term Stability⁵	<0.1% FS	<0.1% FS	<0.1% FS	<0.1% FS
Resolution	±0.005% FS or better	±0.005% FS or better	±0.005% FS or better	±0.005% FS or better
Units of measure	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH2O, inH2O Level: in., ft, mm, cm, m	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH2O, inH2O Level: in., ft, mm, cm, m	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH2O, inH2O Level: in., ft, mm, cm, m	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH2O, inH2O
Temperature Sensor	Silicon	Silicon	Silicon	Silicon
Accuracy	±0.1° C	±0.1° C	±0.1° C	±0.1° C
Resolution	0.01° C or better	0.01° C or better	0.01° C or better	0.01° C or better
Units of measure	Celsius or Fahrenheit	Celsius or Fahrenheit	Celsius or Fahrenheit	Celsius or Fahrenheit
Warranty⁶	3 years	3 years	3 years	3 years
Notes	¹ Temperature range for non-freezing liquids. ² Typical battery life when used within the factory-calibrated temperature range. ³ 1 data record = date/time plus 2 parameters logged for a total of 360,000, 750,000, and 180,000 data points. (No wrapping) ⁴ Across factory-calibrated pressure and temperature ranges. ⁵ Includes linearity and hysteresis over 1 year. ⁶ Up to 5-year (total) extended warranties are available for all sensors. Delrin is a registered trademark of E.I. du Pont de Nemours and Company. Specifications are subject to change without notice.			

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Appendix D

Appendix D

Brooks Applied Laboratory SOP Cover Pages

SOP #BAL-3200

**Determination of Methyl Mercury by Aqueous Phase Ethylation, Trap Pre-Collection, Isothermal GC Separation, and CVAFS Detection:
BAL Procedure for EPA Method 1630 (Aqueous Samples) and EPA Method 1630, Modified (Solid Samples)**


Brooks Applied Labs

Revision 002

Written 2/12/16

Revised 7/7/17

Reviewed



BAL VP of Operations



BAL VP of Quality



Hg Group Leader

7/7/17

Date

7/7/17

Date

7/17/17

Date

SOP #BAL-3900

**Five-Step Selective Sequential Extraction (SSE) Procedure to Quantify
Mercury Fractions in Sediments, Soils, and Other Solids**

Brooks Applied Labs

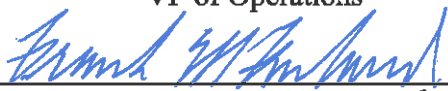
Supersedes BR-0013 rev 006 and ASC-074

Revision 001
Written 2/24/16

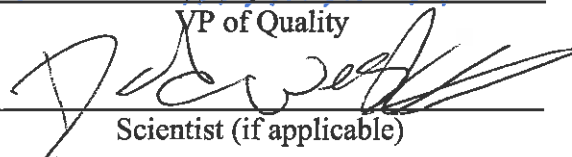
Reviewed



VP of Operations




VP of Quality



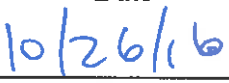
Scientist (if applicable)



Date



Date



Date

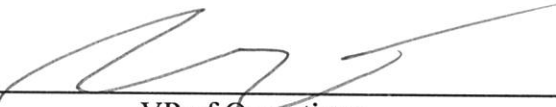
SOP #BAL-3101

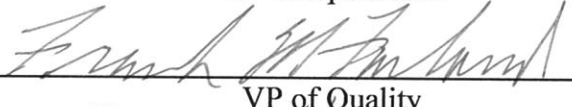
BAL Procedure for EPA Method 1631, Appendix to (1/01): Total Mercury in Tissue, Sludge, Sediment, and Soil by Acid Digestion and BrCl Oxidation by Cold Vapor Atomic Fluorescence Spectrophotometry (CVAFS)

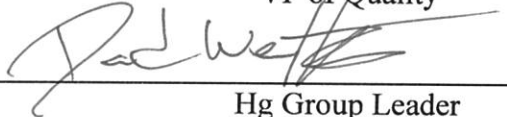
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Revision 005
Written 2/11/16
Revised 5/22/18

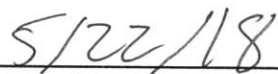
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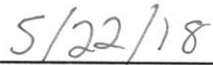


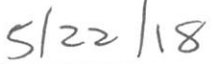
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